AGILE INITIATIVE

OXFORD MARTIN SCHOOL

UNIVERSITY OF OXFORD

Environment and National Security - Exploring the Risk Pathways

FORWARD-LOOKING RESEARCH AGENDA

September 2026

About

This report is the central output of the Agile Initiative's Environment and National Security: Exploring the Risk Pathways project. Designed to be accessible, it provides a forward-looking research agenda for research and policy audiences. It provides a conceptual framework, a baseline of current UK Government understanding and response, thematic reviews of policy questions and evidence gaps, and discussion of communication challenges and opportunities and possible policy interventions.

Project

The Environment and National Security project explored environment to national security risk pathways and their implications for the UK. A six-month sprint project, convened by the Agile Initiative and the Oxford Martin School, it brought together Oxford University experts with politicians, policymakers and professionals in and beyond the climate, nature and national security space. The collaborative and interdisciplinary project created a baseline of understanding, identified urgent evidence gaps and opportunities, and provided rapid responses to questions identified as policy priorities. Read about the project.

Other reports

The project has also produced six Priority Policy Questions: Summary of Key Findings reports and five long-form Evidence Synthesis reports. Available at on our project website, these are on the following topics:

- The Role of Critical Natural Infrastructure in Supporting UK National Security
- Managing Demand: Energy Security, Food Security and UK National Security
- Climate Risks and Opportunities for Maritime Shipping and UK Trade
- Environment-Driven Mobilities and UK National Security
- Weaponisation of Nature
- Environment and Social Resilience

AGILE INITIATIVE

Contents

Summary

This report presents a forward-looking research agenda to address evidence needs in response to the climate and biosphere emergency and its implications for UK national security. It is the result of a six-month collaboration between researchers from the University of Oxford working closely with policymakers from 15 UK Government departments, statutory bodies, and military services.

National security depends not only on military defence but also on social and geopolitical stability. This in turn depends on a habitable climate and healthy ecosystems that provide food, water and oxygen, protect from hazards and support human wellbeing.

However, climate change and environmental degradation is already directly affecting our way of life in the UK, with droughts, heatwaves, fires and floods causing thousands of deaths, cutting food production, destroying homes, closing schools, disrupting transport, cancelling events, undermining productivity and putting emergency services under extreme stress. Global impacts also cascade to the UK through supply and price shocks, conflicts and instability driven by shortages of food and water. In addition, weak governance has allowed environmental assets to be plundered as an income source for hostile actors and organised crime, and nature loss is being weaponised, accelerating environmental degradation and exacerbating security threats. These threats to UK national security will become much worse if we do not strengthen governance and halt further damage to critical natural systems.

This project therefore brought together researchers and policymakers in a six-month research sprint to develop a conceptual framework on the links between environment and national security, assess the current UK Government position, tackle key policy questions and develop an agenda for future research.

Six key themes were identified

- Critical natural infrastructure
- Food and energy demand
- UK shipping and trade
- Environment-driven mobilities
- Weaponisation of nature
- Societal resilience

Evidence syntheses were carried out for each theme, addressing key questions identified by our policy partners (available on the project webpage). The existing evidence clearly demonstrates the urgent need to protect critical natural systems and strengthen resilience. However, more research is needed to improve understanding of impacts, set up monitoring and early warning systems, and design effective interventions. Behavioural science insights will also be crucial for delivering the changes needed at pace and with public support – including by countering misinformation.

This forward-looking research agenda includes almost 200 suggested questions for future research, grouped across the six themes, with final cross-cutting sections on communication and intervention points. Key findings and research gaps for each theme are summarised below.

I. Critical natural infrastructure

Existing research shows that urgent intervention is needed to protect critical natural systems from further loss and damage. These include; tropical forests and ocean ecosystems which sustain global carbon, oxygen and water cycles, where further degradation could trigger climate tipping points; wild pollinators and pest predators where declining populations could limit crop production globally and threaten the integrity of all land-based vegetated ecosystems; high grade farmland, which is at risk from floods, droughts and soil degradation; and urban green infrastructure, which is vital for climate resilience and human health and wellbeing but is under threat from development pressures.

Future research is needed to clarify the causal chains between nature loss and national security, integrate these links into policymaking, identify and support priority actions to prevent (and where possible reverse) damage to critical natural systems, and monitor the outcomes.

II. Food, energy and water security

Action in these critical and interlinked areas has largely focused on supply, neglecting the importance of managing demand. Saving energy and water and shifting to healthier and more plant-based diets can reduce impacts on climate and nature as well as reducing the severity of supply and price shocks on people.

An integrated research programme is needed on how to deliver these changes through improved public and policymaker literacy, innovative governance that co-ordinates national policy with local initiatives, and learning from behavioural science. Supply security also needs more research, including emergency planning to improve resilience, especially as the current food system relies heavily on water, energy and fossil-fuel derived fertiliser. Focus areas include; how to reduce food waste; how to increase yield sustainably using low-input agro-ecological approaches; how to sustainably decommission end-of-life energy infrastructure and how to scale up renewable energy without damaging critical natural systems.

III. UK shipping and trade

Ninety-eight percent of goods imported to the UK arrive by sea, but ports and workers are vulnerable to climate risks, including at chokepoints such as the Panama Canal, which is vulnerable to drought. Meanwhile, new challenges and opportunities arise from melting of Arctic sea-ice and decarbonisation of shipping, including the need for military ships, equipment and personnel to remain compatible with civilian systems as they shift to clean energy.

This project explored key vulnerabilities and cascading risks for UK supply chains and recommended interventions to enhance resilience and reduce risks of further damage to the environment. It also identified an urgent need for more research to map, monitor and stress-test these dependencies in greater detail.

IV. Environment-driven migration

Currently this mainly involves movement within countries, with movement between countries often targeted towards existing diaspora communities. Interventions need to be designed to counteract destabilising effects, including by supporting vulnerable countries to adapt to climate impacts as far as possible, potentially through mobilising diasporic networks, and by countering harmful and misleading narratives about migration. UK communities are also facing the threat of displacement, mainly due to sea-level rise and coastal erosion, but in future up to a third of all homes could be at risk of flooding. There is a pressing need to improve governance of 'managed retreat' for vulnerable coastal communities, and to design a successor to the Flood Re insurance programme to prevent catastrophic economic and social shocks as more houses are exposed to flood risk and could become uninsurable.

Non-human species are also affected by environmental change and human activity, increasing extinction threats for many species but also leading to threats to humans from movement of pests and diseases. There will be a need to increase public understanding of these risks, and to adopt best practice management approaches from other nations with long-established biosecurity programmes.

V. Weaponisation of nature

This is a growing risk to the UK. This can arise both from direct attacks on nature in the UK by adversaries, which could reduce food and water security and climate resilience, and by deliberate or accidental destruction of nature and earth systems in all parts of the world by enemy or ally, especially if critical tipping points are breached. Urgent action is needed to strengthen and protect the resilience of critical natural infrastructure in the UK and globally, to revive the Environmental Modification Convention and pursue the recognition of ecocide as an international crime to limit risks as far as possible.

More research is needed to develop a clear concept and typology of the weaponisation of nature as the foundation for new policymaking. There is also a requirement to improve risk assessment and attribution tracking for nature weaponisation threats including use of disposable or deniable agents (e.g. drones), and dual civilian-military use technologies like geoengineering. Finally, there is a need to establish how the UK can "protect and prepare" to better anticipate, withstand, and respond to the weaponisation of nature.

VI. Societal resilience and mental health

Environmental stress such as floods, heat, pollution, and food and water insecurity erode the mental, social, and economic capital that allows people, communities, and institutions to absorb and recover from shocks. Investing in resilient societies creates positive feedback loops as they can govern critical naturalinfrastructure better, absorb and act on information on adaptation options more effectively, and recover faster. Nature-rich green spaces – including the under-appreciated 'forgotten ecosystems' outside formally protected areas – support resilience (e.g. cooling, flood protection, pollinator habitat) and give people everyday contact with nature that supports mental capital. There is a pressing need to embed mental, social, and economic capital across project cycles; apply a mental capital equity test to infrastructure and adaptation decisions; and improve planning protection for overlooked habitats.

This important area is critically under-researched. Three key gaps are identified. First, to assess how mental, social, economic, natural, and human capital interact to determine societal resilience, including through enabling processes such as trust, participation, co-production, and social learning. Next, to understand how national mental capital and wellbeing intersect with environmental challenges, including toxins, climate change, and water and food security. Finally, to demonstrate the value of nature for mental and societal resilience, and embed this in policymaking.

Communications

The urgency of the climate and nature crisis needs to be clearly communicated to the public, but this needs to be backed by plans for strong government action and funding to address the risks, to inspire hope and collective action rather than fatalism, panic, apathy or scepticism. Tangible place-based examples of positive solutions to address risks can help to generate a mandate for further action. It is important to tackle misinformation and disinformation and demonstrate to policymakers and the public that an integrated policy to improve climate, nature, food, water and energy security will also help to address other immediate problems such as high food and energy prices and the economic cost of climate and nature degradation.

Potential interventions

The six project themes identified 54 potential interventions. An integrated approach is needed to identify options with multiple benefits that avoid conflicts between different dimensions of security. For example, accelerating the shift to a circular economy can reduce waste of food, water, energy and materials, thus reducing the need to extract critical minerals from sensitive ecosystems such as the seabed. Stronger planning guidance is also needed to ensure that wind and solar farms avoid significant impacts on nature. Much stronger global governance is needed to prevent use of high-risk geoengineering options and weaponisation of nature and weather.

Analysis of the current policy baseline

The project found that environment-security links were framed differently across government, with energy security currently receiving the most focus. However, while the UK Government has been a strong global leader on tackling climate change over the last 20 years and is now starting to address nature security, there are signs that climate security and nature protection are slipping down the agenda. This appears to be due to several factors: a focus on more immediate issues, such as the US/Israel-Iran and Russia-Ukraine conflicts and the cost-of-living crisis; external political and media pressure (driven by misinformation and vested interests); and the influence of false narratives that sustainability limits growth and is not relevant for traditional security departments.

Co-ordinated action across government is critical

Cross-departmental working groups on climate security are proving effective for breaking down silos and developing a common framework of understanding, which is essential to allow effective, co-ordinated action. This process could be facilitated through a networking directory to identify relevant staff in different departments.

Next steps

To build on the momentum of this sprint, next steps should involve wider discussions with other academics, policymakers and practitioners including businesses, national and local government, and the third sector, leading to an action agenda to embed the links between environment and security into policy and practice.

1. Introduction

This forward-looking research agenda was produced as part of a six-month research "sprint" by researchers from the University of Oxford working closely with policymakers from UK Government departments, statutory bodies, and military services in roles encompassing climate, nature and national security responsibilities. Dialogue with policymakers identified six priority focus areas, which form the backbone of this research agenda:

- Critical natural infrastructure
- Resource management, with a focus on food and energy demand
- UK shipping and trade
- Downstream migration response
- Weaponisation of nature
- Societal resilience and mental capital

Separate outputs have been produced for each of these themes, addressing priority knowledge gaps identified by policymakers, with researchers in each area producing an evidence synthesis report and a shorter summary report of key findings for policymakers (available on the project webpage.) Each of these outputs gives useful background and context to support the research questions identified in this overarching report.

The remainder of this introduction explains the background and aims of this study. Section 2 presents a conceptual framework showing the causal pathways that link climate and biodiversity to national security, showing where our six key themes fit into this picture. Section 3 summarises the current policy baseline, based on a systematic review of current UK Government policy reports and other outputs as well as insights from interviews with policymakers. It assesses the use of different environmental security concepts and definitions and explores the priority given to these issues by each department.

> *"security means providing a stable and secure future, and stopping conflict. A secure future must be sustainable, otherwise people will fight over resources."*

The core of the report is sections 4 to 9, which present relevant research questions to address identified policy and knowledge gaps for each of the six priority themes.

Effective communication of these issues is critical, to motivate urgent action. Section 10 therefore describes key challenges, limitations, opportunities and lessons linked to communicating the environment-national security nexus. Section 11 then identifies promising behavioural and institutional levers to support effective policy interventions. Finally, Section 12 provides overall conclusions and offers suggestions for next steps. A glossary defining key terms is included at the end of the document.

1.1. The context: growing security risks from environmental damage

The environment and security are inextricably linked. As one of our policy partners pointed out, "*security means providing a stable and secure future, and stopping conflict. A secure future must be sustainable, otherwise people will fight over resources.*" - Government stakeholder

National security is often associated with defence, borders, intelligence, and military capability. These remain essential, but they no longer capture the full range of risks facing the UK. In an era of climate disruption, geopolitical instability, cyber and information threats, supply chain shocks, ecological degradation, and economic manipulation and volatility, national security must also be understood as the capacity of the state and society to protect the systems that allow people to live safely, the economy to function, and public institutions to respond effectively during disruption.

The UK's National Security Strategy 2025[1] reflects this broader understanding. It identifies the UK as operating in an era of "radical uncertainty" and frames national security as a cross-government agenda that includes defence and deterrence, but also resilience, economic security, technological capability, supply chain preparedness, and protection of critical national infrastructure. These points are also made clearly in a recent UK Government national security assessment on global biodiversity loss.[2] Today, national security requires not only responding to hostile actors but also reducing exposure to systemic shocks that can undermine public welfare, economic stability, and democratic confidence.

For this report, national security is therefore defined as the UK's ability to protect its population, economy, critical infrastructure, institutions, and strategic autonomy from shocks and threats, whether military, geopolitical, economic, technological, environmental, or social. This definition is deliberately broader than a defence-only understanding of security. It recognises that disruptions to energy, food, water, ecosystems, supply chains, public health, and digital systems, for example, can create security consequences even when they do not originate from armed conflict or the malign activities of adversarial state and non-state actors.

It is impossible to decouple the rise in geopolitical tensions, and the implications for defence priorities and spending, from the societal implications of the cascading effects of climate breakdown and biodiversity loss

This issue is growing in urgency. It is impossible to decouple the rise in geopolitical tensions, and the implications for defence priorities and spending, from the societal implications of the cascading effects of climate breakdown and biodiversity loss. As highlighted by recent global events and countless studies, the climate and nature crisis poses risks to food, water and energy security, public health, economic prosperity and social cohesion, undermining the welfare of both current and future generations. Our ability to respond effectively to these crises is undermined by the spread of misinformation and disinformation, political polarisation and a lack of awareness of the scientific evidence that permeate both public awareness and global political discourse.

1.2. The aim of this study: addressing policy-relevant questions

Policymakers and research funders are looking to the research community to provide evidence to answer increasingly complex questions at the intersection of climate, nature and national security. This is reflected in UK Government priorities and associated research funding, including through the strategic focus of UKRI and NERC on growth, resilience and environmental security.

These issues are highly politicised and emotive, requiring researchers, politicians, policy makers, professionals and civil society actors to take a holistic and participatory approach, collaborating with stakeholders with very different perspectives.

This research sprint aimed to support researchers and policymakers to collaborate on a forward-looking agenda that puts environmental and social science at the heart of decision-making on national security. Through the convening power of the Agile Initiative at the Oxford Martin School, it brought together policymakers working on national-level security, defence and preparedness with those working on environmental and human security, and researchers from a wide range of disciplines including biodiversity, climate science, social science, food systems, energy policy, infrastructure systems modelling, health, anthropology and behavioural science.

Through a series of workshops and interviews, the project team identified key questions of interest to policymakers. For each of the six project themes, two or three key questions were addressed through rapid research and literature reviews, with findings presented in the evidence synthesis reports and summary reports (available on the project webpage). Further questions emerged from stakeholder discussions, expert input and literature reviews and were collated into this forward-looking agenda. It is hoped that this study will help to inform future research to address these urgent issues.

2. Conceptual framework and causal pathways

The project developed a framework to show the pathways connecting the environment to national security (Figure 1). The top half of the diagram shows the overall framework. It starts with the foundations of a healthy environment – biodiverse ecosystems and a stable climate, on the left-hand side of the diagram. These are interdependent – climate stability requires healthy ecosystems, and healthy ecosystems in turn need a stable climate. These critical natural assets underpin the delivery of resources, services and infrastructure, shown in the centre of the diagram, and these in turn support socio-economic prosperity, geopolitical stability and national security, shown on the right.

However, unsustainable use of resources, construction of infrastructure and operation of services can also damage biodiversity and climate stability, undermining provision of essential goods and services and thus also undermining socio-economic prosperity and geopolitical stability, as indicated by the black arrows. This can also drive migration from areas suffering climate and ecosystem stress and resource shortages, which can have complex impacts on economic prosperity, stability and security in the different regions affected, depending on governance, societal responses and other factors.

This framework enabled the project to identify broad strategies for tackling the risks of environmental degradation, which correspond to the project's six research themes:

- Protecting and strengthening critical natural infrastructure
- Managing resources more sustainably, both to avoid impacts on natural infrastructure and to avoid shocks and shortages
- Developing more resilient and sustainable infrastructure, services and supply chains
- Understanding and addressing environment-driven mobility and migration
- Understanding how nature loss can be weaponised
- Strengthening the resilience of societies and economies

In addition, the diagram shows the all-encompassing importance of effective, accountable and inclusive governance. Accordingly, Sections 10 and 11 of this report provide guidance on how to communicate environment-security risk pathways effectively to the public and policymakers, and how to identify effective interventions.

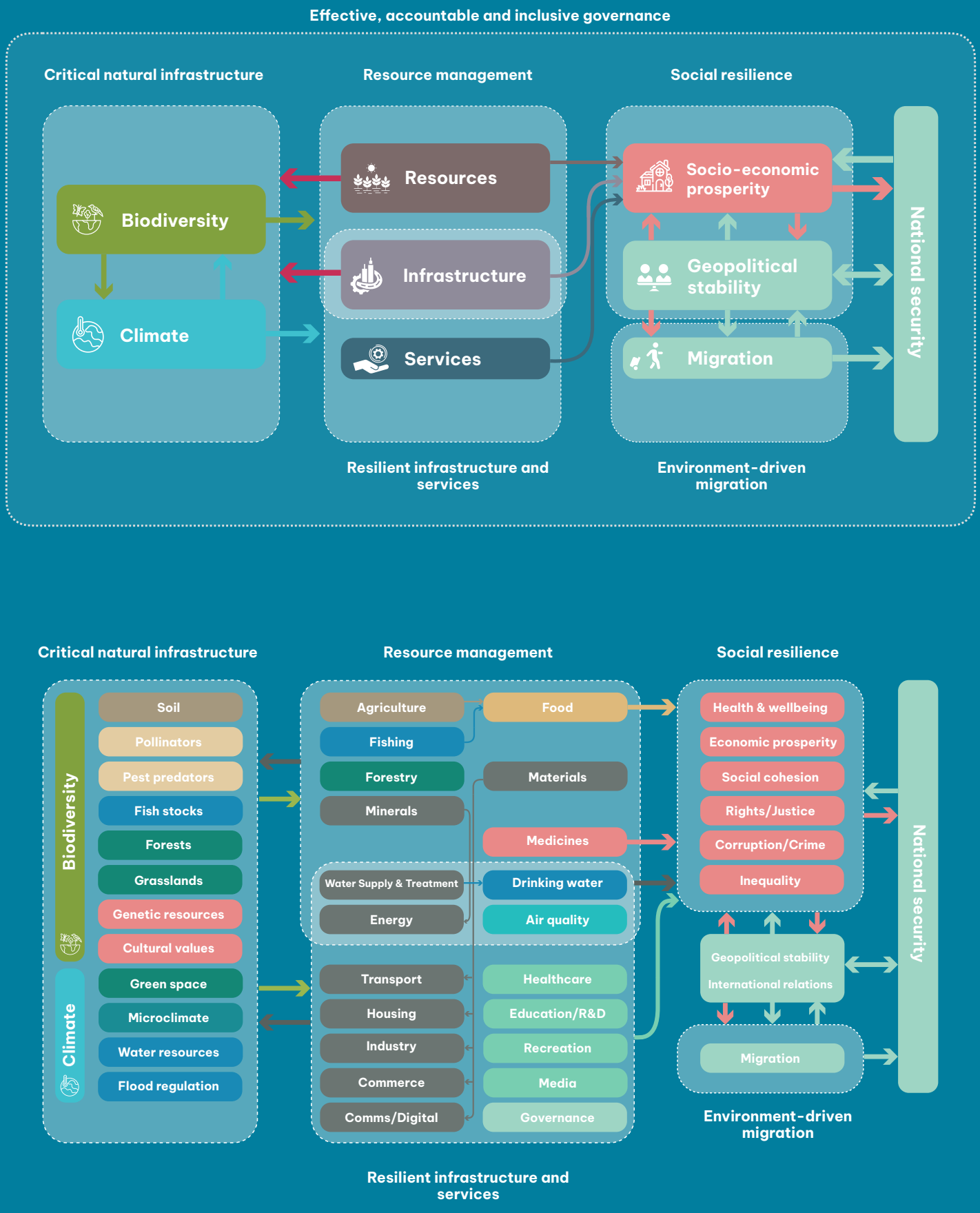


Figure 1. Conceptual framework showing high level links between environmental integrity and national security. High level overview (top) expanded into sectors (below).

The lower part of Figure 1 expands the high-level diagram to show some of the individual goods and services provided by nature, and how these feed into different sectors of the economy and society. It shows how different sectors, assets and services are closely interlinked, and how changes in one area affect others. For example:

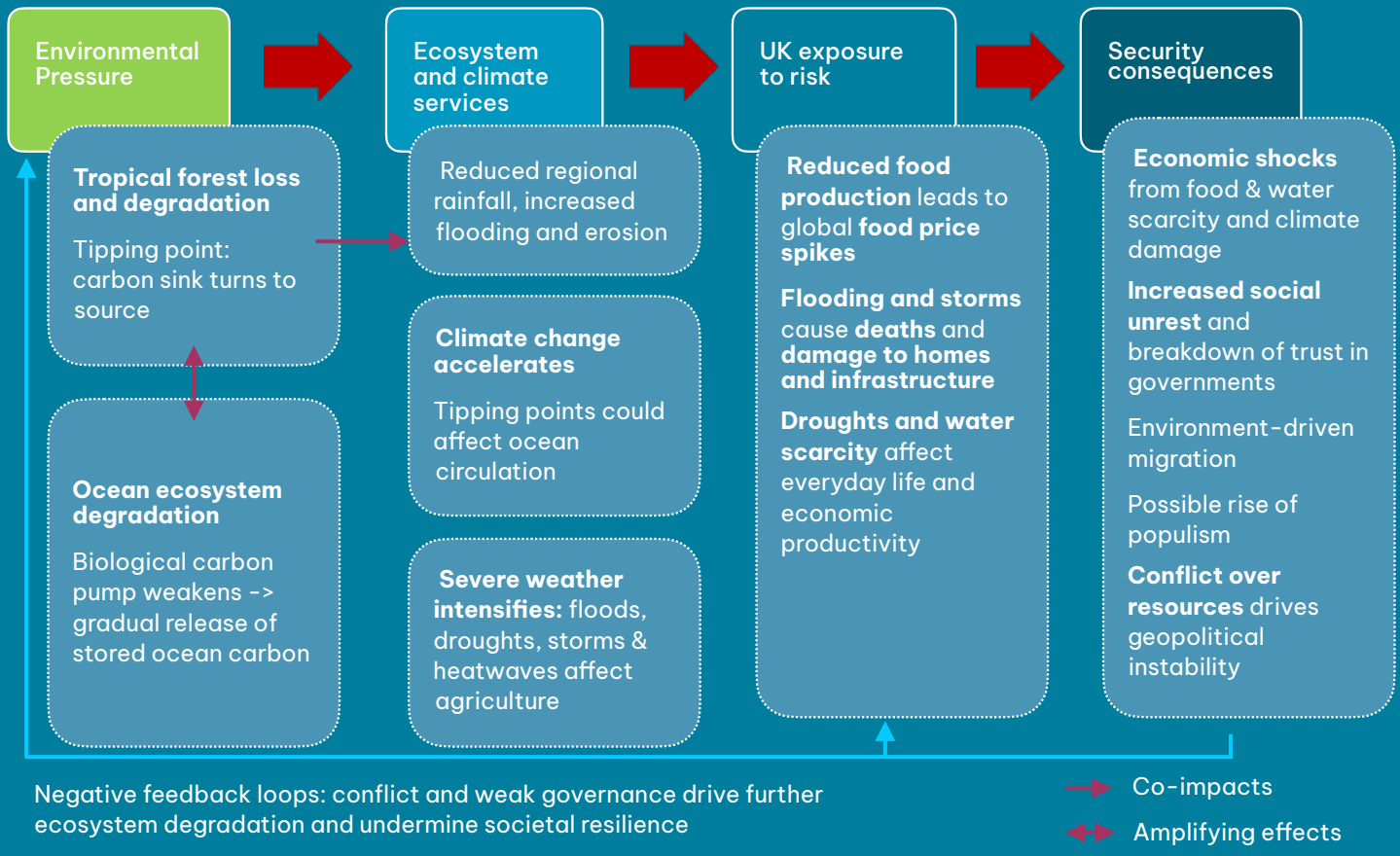
- Healthy soils, pollinators, pest predators and water supplies underpin agriculture and food production but are also affected by farming practices;
- Forests, grasslands and other ecosystems store carbon and protect against flooding and erosion but are also affected by pressure from the infrastructure and agriculture sectors;
- Genetic diversity is a source of new medicines and crop varieties which underpin health and societal resilience; and
- Green spaces and trees help to cool towns and cities, and provide nature-rich spaces for recreation that support human health and wellbeing.

The figure also demonstrate that a resilient society feeds back into supporting the service sectors and the rest of the economy.

These diagrams can be used as a starting point for examining individual causal pathways, cascading risks, feedback loops and intervention points in specific systems. For example, Figure 2 on the following page shows the links between tropical forests and oceans, carbon and water cycles, food and water security and national security (see the evidence synthesis report on Critical Natural Infrastructure[3] for full details). The top diagram highlights the current situation, where weak environmental governance allows degradation of critical tropical forest and ocean ecosystems. This shows how carbon emissions from degrading tropical forests and loss of stored ocean carbon could amplify each other, as they each drive additional climate change which causes further degradation of both systems. Forest loss would also lead to adverse co-impacts from loss of other ecosystem services, including rainfall generation and flood resilience. Conflict over diminishing food and water resources further weakens governance and drives further environmental degradation in a negative feedback loop.

strong, equitable and inclusive governance could tackle the root causes of the problem by protecting and restoring critical natural systems, shifting to a system of cascading benefits, co-benefits, reinforcing effects and positive feedback loops

This pathway diagram can be used to spark conversations about potential intervention points. While measures to adapt to change are vital, it would be difficult or impossible to adapt to extreme changes such as those that could result from climate tipping points. However, strong, equitable and inclusive governance could tackle the root causes of the problem by protecting and restoring critical natural systems, shifting to a system of cascading benefits, co-benefits, reinforcing effects and positive feedback loops that deliver multiple benefits for society, meet social needs and restore trust in government, as shown in the lower diagram.



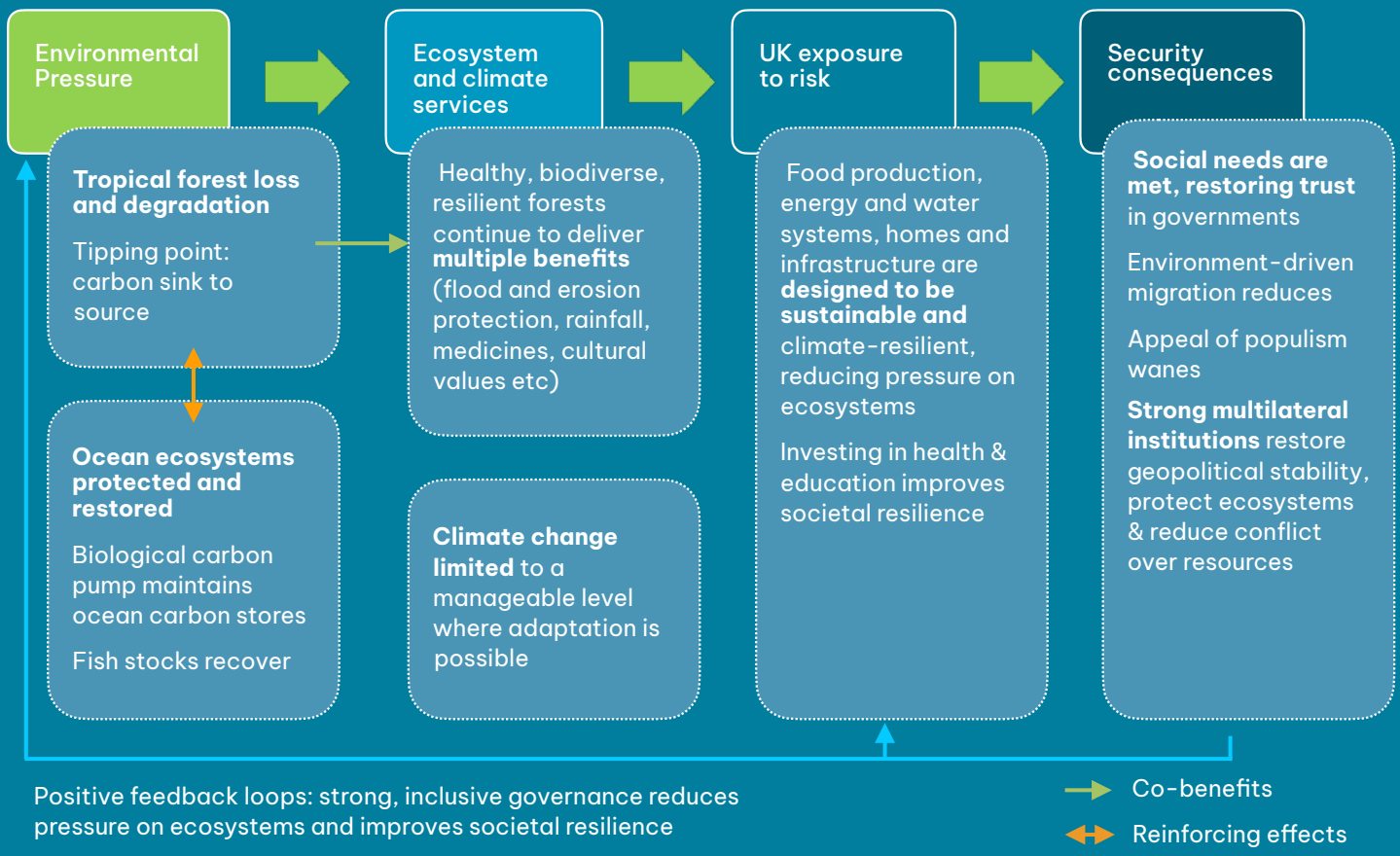


Figure 2. Example causal pathway for the links between critical natural systems (tropical forests and oceans), carbon and water cycles and national security. This shows a situation with weak environmental governance leading to cascading risks (top) and strong, equitable and inclusive governance leading to cascading benefits (bottom)

While these diagrams clearly cannot show all the possible impacts, risks and interlinkages in our highly complex natural and social systems, they are intended to inform discussions, raise awareness and encourage a systems approach that breaks down policy silos across government. In future, the diagrams could be linked to a database showing relevant evidence for each link between system components.

In reality, the simplified links shown here will be subject to different timescales, uncertainty and non-linearity, and will depend on complex interacting social, political, environmental and economic effects. This broad conceptual framework could therefore act as a starting point for more detailed systems diagrams and models focusing on specific issues, showing cascading risks, feedback loops, dependencies, two-way interactions and intervention points, and potentially allowing identification of emergent properties.

However, as not all these effects can be quantified in complex systems, the priority is to provide frameworks that can identify the main cascading risks and support robust decision-making in the face of uncertainty. A key strategy here is to focus on tackling the underlying causes of environmental degradation and societal insecurity (through strong, equitable and inclusive governance) rather than only treating the symptoms, and identifying mitigation options with multiple co-benefits that avoid conflicts and trade-offs.

3. Policy baseline: Where are we? UK Government's environment and national security position

3.1. Summary

This section offers a baseline assessment of how environment-related national security issues are currently understood across UK Government departments, covering the terminology being used, departmental priorities, and implications for future policy development.

It draws on publicly available departmental material and interviews with policymakers. To protect anonymity, insights from interviews are used only in aggregate. The central finding is that whilst UK Government activity in this area is increasing, there is considerable conceptual ambiguity, response is fragmented and siloed, and certain areas of activity are subject to reframing, resource cuts, and de-prioritisation. This results in suboptimal understanding and response.

Three narratives dominate the UK Government position.

A conflict narrative linking environmental change to scarcity, competition, migration, instability and violence.

A threat-multiplier narrative treating climate and environmental pressures as amplifiers of existing geopolitical, development, economic, and security risks.

A risk and resilience narrative focusing on exposure, vulnerability, preparedness, community capacity, and adaptation.

Departments are addressing risks through adjacent, sometimes competing, vocabularies and frames – adaptation, climate security, economic security, energy security, environmental security, nature security, resilience, and supply security – to describe different risks, evidence standards, and routes to action. Although different framings can be useful to appeal to different departmental priorities and responsibilities, this level of incoherence and lack of a common working picture risks leading to inaction, inefficiencies, and unintended consequences.

The central finding is that whilst UK Government activity in this area is increasing, there is considerable conceptual ambiguity, response is fragmented and siloed, and certain areas of activity are subject to reframing, resource cuts, and de-prioritisation

There are unequal levels of use and maturity across key concepts. Energy security, which can encompass supply, demand, affordability, infrastructure, diversification, critical minerals, domestic resilience, and geopolitical exposure, is used most extensively with the clearest cross-departmental understanding of what it entails. Climate security has wide resonance with many policymakers but also fuzzy conceptual boundaries. With its encapsulation of climate impacts on defence, development, diplomacy, conflict, health, migration, and access to energy, food, and water, departments recognise the strength of the concept for encouraging consideration of complex interconnections, but also stress the need for drawing boundaries around specific areas that can be embedded into decision-making processes across government. Environmental security and nature security are also emerging as strong concepts in the nature-focused departments, but their use is less widespread and their meaning is less settled. When deployed, these two terms are usually associated with risks in the areas of biodiversity loss, ecosystem services, economic resilience, natural capital, and public health, with interviewees reporting that the links to conventional "hard" security matters were less visible.

Departmental approaches link to respective mandates which further shape focus and concepts. The Cabinet Office uses a "whole-system" national security frame that integrates risk and resilience. MOD focuses on environmental risk as it impacts operational conditions, capabilities, and infrastructure, whilst the Home Office focuses on migration, borders, public safety, and emergency services. The FCDO focuses on climate, conflict, development, and international partnership. Defra and Natural England focus on adaptation, biosecurity, ecosystem resilience, natural capital, and public health. HM Treasury and DESNZ afford primacy to the economic-security dimension through fiscal exposure, energy supply, energy affordability, investment, productivity, and natural capital, with DESNZ having lead responsibility for mitigation through delivering the Net Zero target.

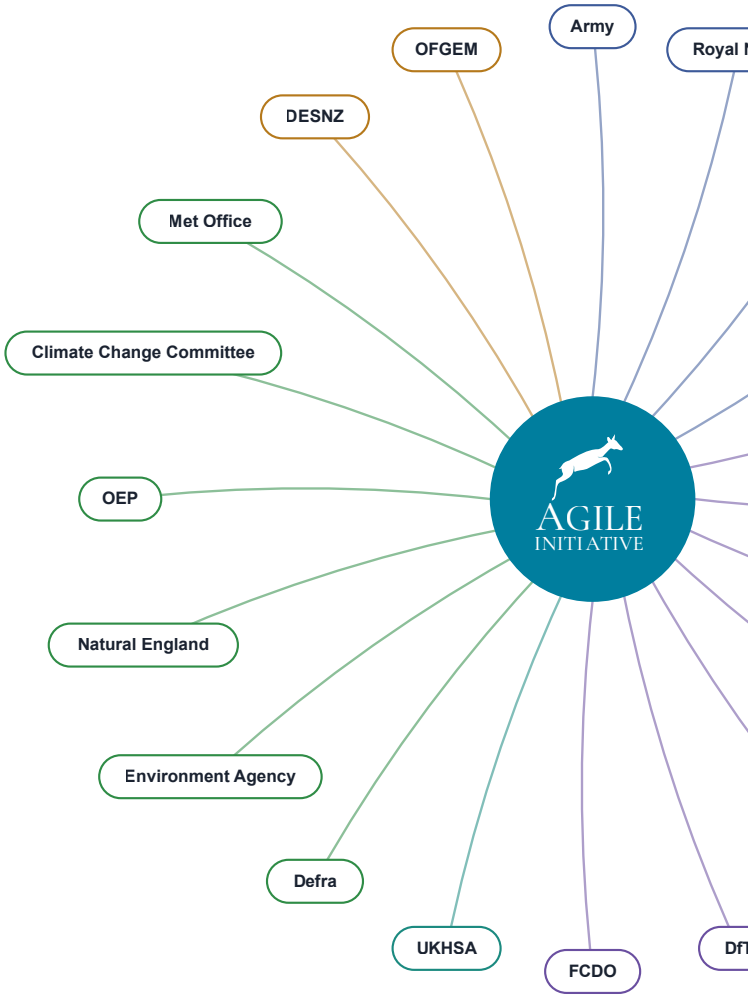
Attention cycles and domestic and international events can divert policy bandwidth from longer-term systemic risks, even where these are recognised to be strategically significant. Across departments, concepts which are more politically legible see greater deployment. Energy security is considered tangible and immediate, helping to inform its ongoing prioritisation, although the optimum strategy can be politically contested such as in debates about drilling for more UK oil and gas. Nature security is seen as less relevant in many departments because causal chains from ecosystem degradation or biodiversity loss to national-security outcomes are seen as being complex, longer-term, and more mediated through other systems.

3.2.Purpose and method

The baselining research involved engagement with many UK Government and adjacent departments. These include British Army, Cabinet Office, Climate Change Committee (CCC), Defra, DESNZ, DfE, DfT, DSTL, Environment Agency, FCDO, Go-Science, HM Treasury, UKHSA, the OEP, OFGEM, Met Office, MHCLG, MOD, Natural England, and Royal Navy. To ensure the inclusion of multilateral perspectives, officials from the UN and NATO also had the opportunity to input.

The analysis draws from public-facing government material and non-attributable interviews. The documentary material analysed includes strategic assessments on national security, defence, development, risk, and resilience as well as policy outputs on adaptation, energy, climate, environment, biodiversity and nature.[4] Between January and mid-July 2026, 11 in-depth, semi-structured research interviews (mainly one-to-one) and three large stakeholder workshopping sessions were held with policy officials, with follow-up exchanges undertaken by email. To ensure interviewees are unidentifiable, the presentation of interview data avoids attribution to individuals, roles, units or directorates. Where interview findings are presented, they should be read as indicating recurring practitioner perceptions not formal departmental positions.

The assessment is less concerned with whether a department uses a precise phrase (e.g. "climate security"), and more with how specific phrases and concepts are being applied in policy work. This is important as both day-to-day terminology and the broader conceptual foundations shape policy processes and outcomes. Terminology and concepts can affect what evidence is requested, what risk pathways are considered, which departments are involved, which budgets and capabilities can be drawn upon, and, ultimately, whether a response is prioritised. Language is therefore treated as an operational variable, not merely a communications choice.



3.3. Terminology and framing narratives

This assessment identifies five concepts which are of direct relevance to the links between environmental integrity and national security: climate security, energy security, environmental security, nature security, and ecological security. These overlap, but should not be treated as interchangeable. The project did not formally assess use of the concepts of food and water security as they are widely accepted and understood. It is noted, however, that there are increasing calls to treat water, energy and food security as part of an interdependent "WEF" nexus.

Climate security

Climate security concerns the security implications of anthropogenic climate change. This includes how heat, drought, flood, extreme weather, sea-level rise and climate variability interact with food systems, water stress, health, infrastructure, livelihoods, migration, instability, and conflict. The concept is the broadest and most salient bridge between environmental change and national security. Its value is its convening power: it is not owned by one department and therefore can bring different actors into the same response frame. However, as climate change touches almost every policy domain, climate security can require breaking down into specific areas to guide prioritisation, e.g. by specifying what is in scope, evidence standards used, and relevant decision routes in different departmental contexts.[5]

Energy security

This concerns reliable and resilient access to energy, and in its broadest sense also includes the complementary goals of affordability and environmental sustainability.[6] In current UK policy, it covers security of domestic production, imports, infrastructure, markets and emergency response capacity, and considers factors such as demand management, price, fuel poverty, access to critical minerals, cybersecurity, diversification, interdependence with partners, and exposure to geopolitical disruption. It has the clearest and least contested short-term operational relevance across departments due to the obvious importance of access to affordable energy for people and the economy. Energy security is also legible because it can be measured and acted upon: supply can be diversified, infrastructure can be hardened, reserves can be assessed, markets can be monitored, and dependencies can be mapped. It is therefore a good example of a concept that has moved from broad concern to routable policy practice.[7]

Environmental security

Environmental security is a broader concept. Defra define it in terms of safeguarding people, nature, and the economy by managing climate risks, environmental hazards, and biosecurity threats whilst ensuring a healthy, resilient environment.[8] Like climate security, this makes it a potentially useful umbrella concept, which can recognise systemic risks that transcend departmental purviews, but it may need to be broken down into more specific areas to inform decisions. In policy, it tends to apply to risk, resilience, adaptation, public health, and economic outcomes, as well as concern over climate and natural hazards, pollution, biosecurity, resource pressure, and the weaponisation or manipulation of environmental systems.

Nature security

Nature security is the least settled of the main policy terms in current policy use. It appears most clearly as a frame for tipping points, biodiversity loss, ecosystem collapse, natural capital, ecosystem services, and nature-related risk. A recent nature security assessment, produced by the Joint Intelligence Committee but published by Defra, indicates growing recognition that biodiversity and ecosystem degradation can have national security consequences, particularly through food, water, health, economic, and stability pathways.[9] However, the concept remains under-specified. Interviewees suggested that although the security relevance of nature is accepted in some parts of government, nature security is harder to operationalise because its causal chains are more complex, less visible, and often mediated through other policy systems (e.g. climate, food, water, health). Despite the focus on tipping points in the aforementioned nature security assessment, officials from many departments suggested that governments – the UK and globally – are being slow to respond to such risks, for various reasons including a perception of high economic costs, lack of decision-making tools that account for uncertain thresholds and tipping points, and failure to recognise cross-system early warning indicators.

Ecological security

Ecological security is analytically distinct. It treats ecosystems themselves – rather than states, economies or human communities – as referent objects of security. This is valuable as a frame of scientific analysis, but it is not yet a prominent UK Government policy term. For UK policymakers, ecological security is therefore currently recognised as a technical term used mainly for specific types of scientific analysis.[10] However, the term has been used in reports by the US Council on Strategic Risks that identify ecological disruption as a major and underappreciated security threat.[11]

Conceptual narratives

Three main narratives structure the use of these concepts in cross-departmental contexts. The *conflict narrative* links environmental change to scarcity, competition, migration, instability, and violence. It maps most closely onto traditional state-centred security. The *threat-multiplier narrative* treats environmental change as an amplifier of existing fragility, geopolitical risk, development pressure and conflict dynamics. It is emphasised in hard security, international security, and multilateral settings, as well as in climate change adaptation, environmental integrity and food security. The *risk and resilience narrative* focuses on hazards, vulnerability, exposure, preparedness, adaptation, infrastructure, public health, economic resilience, and community capacity. It resonates closely with human security and civil resilience frameworks.[12]

These conceptual distinctions matter because they determine policy routing. A drought framed as conflict risk may route into defence, diplomacy, stabilisation, intelligence, or border analysis. The same drought framed as resilience risk may route into water planning, infrastructure, health, local resilience, adaptation finance, or social protection. A biodiversity loss issue framed as natural capital may route through HM Treasury, Defra or economic policy; framed as food-system security, it may become a national resilience concern; framed as instability risk, it may become relevant to MOD, FCDO, or the Cabinet Office. The same underlying environmental signal therefore might produce different policy responses depending on the applied conceptual scaffold(s). However, these frames can and do co-exist and this can be useful to highlight saliency across different departments.

3.4.Departmental priorities and actors

Analysis of departmental publications and policy interviews revealed a range of terminology, concepts and framings embedded in policy use across different departments (Table 1). This analysis provides a baseline of policy tendencies rather than a definitive statement of departmental doctrine.

Table 1. Concepts and framings in use in UK Government departments based on publications and interviews

Department / body	Main concepts present	Dominant framing	Policy position
Cabinet Office	Energy security (explicit use) Climate, biodiversity, environment and nature prominent	Climate as threat multiplier; energy as geopolitical and supply risk; environment and nature as resilience risk	Central coordination role. National-security and risk material links climate, biodiversity, energy and degradation to resilience, global order, economic stability and security
Defra	Climate security, environmental security, and energy security (explicit use) Nature security emerging (new research project)	Risk, resilience, adaptation, and biosecurity, with some conflict and threat-multiplier language	Strongest basis for environmental security as adaptation, public health, nature, biosecurity, infrastructure and community/ economic resilience
MOD	Climate security and energy security (explicit use)	Conflict, operational resilience, and military effectiveness	Climate and environmental degradation are linked to instability, migration, resource competition, operating environments, estate resilience and military self-sustainment
DESNZ	Climate security and energy security (explicit use)	Energy supply, affordability, transition resilience and strategic autonomy. Net Zero for climate security.	Principal owner of energy security; connects domestic supply, imports, diversification, critical minerals, demand reduction and clean-energy leadership
Natural England	Security terms mostly used implicitly. Strategy is to recover nature for growth, health & security	Nature loss / climate change as economic, health, and resilience risks. Positive benefits of nature recovery	Frames nature through natural capital, health, growth, adaptation, biodiversity, and resource resilience rather than hard-security doctrine
Met Office	Climate security and energy security (explicit use)	Scientific and analytical support to climate-security and energy-resilience agendas	Provides climate, weather, and energy-services evidence, particularly in support of international security, resilience and partner-government analysis

Department / body	Main concepts present	Dominant framing	Policy position
FCDO	Climate security, environmental security and energy security (explicit use). Nature implicit	Threat multiplier, conflict, development and international partnership	Principal bridge between climate security, fragility, migration, food and water stress, conflict prevention, development and multilateral response
HM Treasury	Climate security and energy security (explicit use) Environment/nature implicit	Economic resilience, fiscal exposure, natural capital, and supply risk	Utilises the agenda through economic security: fiscal risk, investment, productivity, infrastructure, financial stability and natural capital
Home Office	Climate security (explicit use)	Migration, public safety, homeland security, border, and emergency-service risk	Climate treated as a rising pressure on migration flows, public safety, drugs trafficking, emergency services, borders and domestic security functions

The Cabinet Office is closest to being a system-level owner because it holds national-security, risk, and resilience equities. The Integrated Review Refresh, National Security Strategy, and National Risk Register each connect climate change, biodiversity loss, energy disruption, supply chains, economic exposure and resilience to wider national-security concerns.[13] However, these Cabinet Office materials do not create one settled definition of environment and national security. Instead, they aggregate several routes: energy as geopolitical and supply exposure, climate as a multiplier of strategic hazards, and environment/ nature degradation as resilience, economic, and systemic risk.

Defra and **Natural England** provide the strongest basis for a risk-and-resilience interpretation. Their material frames environmental security through adaptation, nature recovery, food security, biosecurity, hazards, health, infrastructure, communities, economic resilience, and natural capital.[14] This is important operationally because it captures the domestic and systemic dimensions of the agenda. However, it can also mean that environmental and nature security remain located within resilience and environmental policy, rather than national security response. Interviews reinforced this point, with many participants recognising the strategic importance of nature and environmental security, but describing it as less immediately tangible than energy or climate security. However, nature recovery was considered to have broad political appeal (unlike the highly polarised Net Zero debate), and Natural England's strategy emphasises the positive benefits of nature recovery and nature-based solutions (NbS) for health, biodiversity and the economy as well as for security.

MOD and the **Home Office** both translate environmental change into traditional security pathways. MOD publications link climate and environmental degradation to instability, migration, resource competition, infrastructure, operating conditions, and resilience of the defence estate. Home Office publications link climate change to issues of migration, borders, public safety, emergency services, drugs trafficking, and domestic security functions.[15] These framings are important because they are routable through existing security structures. The risk is that

they privilege the most visible downstream effects – migration, instability or operational disruption – over upstream environmental drivers and preventive interventions.

FCDO is a major bridge between environmental security and international policy, together with Defra and DESNZ who work on the UK's role in multilateral climate and biodiversity agreements. FCDO publications connect climate change, environmental degradation, and nature loss to conflict, fragility, migration, food and water stress, poverty reduction, development, peace, and multilateral cooperation.[16] This is where the threat-multiplier narrative is most useful and apparent. It allows climate and environmental pressures to be treated as part of wider political, social, and economic systems rather than as standalone hazards.

The Met Office supplies scientific and analytical capability through weather, climate and climate security forecasting and decision-support to other government departments, primarily through a risk and resilience lens (e.g. forecasting severe weather events or wind and solar energy output).[17]

as many interviewees observed, environment security risks become comprehensible and, in turn, actionable when presented as a calculation of costs and returns

HM Treasury and **DESNZ** both cover climate and energy security. DESNZ focuses on domestic supply, affordability, demand reduction, system resilience, and clean-energy transition, while HM Treasury concentrates on the economic relevance, especially through the economic framing of risk: fiscal exposure, investment, productivity, natural capital, green growth, infrastructure and financial stability.[18] This framing matters because, as many interviewees observed, environment security risks become comprehensible and, in turn, actionable when presented as a calculation of costs and returns. Nature loss, for example, becomes more legible and policy-resonant when linked to food prices, insurance exposure, infrastructure risk, supply chains, productivity, and/or public spending.

3.5. Whole-of-government trends

Six whole-of-government trends can be identified (see Figure 3 below).

The dominance of energy security and, increasingly, climate security

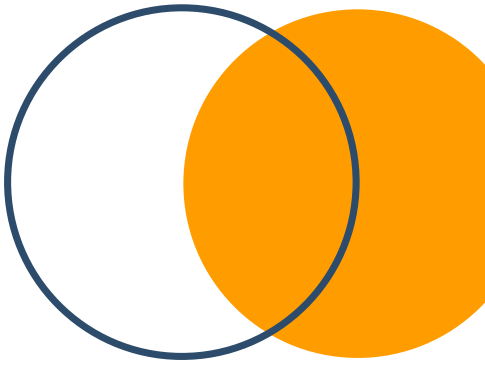
Both terms are in regular and explicit use across seven of the nine departments or bodies assessed. Interviewees also identified them as the most familiar and functional concepts. Energy security is usable because it has a tangible policy object: supply, demand, price, access, reliability, infrastructure, and dependence. However, despite its tangibility, energy security is subject to politicalisation and different meanings could be operationalised by different political actors (as recent policy statements by Labour, Conservative and Reform demonstrate). Climate security is usable for a different reason: it cuts across departmental boundaries and is not wholly claimable by any single department – thereby affording it convening power.

Climate security has reach but weak boundaries

When implicit use is included, climate security appears across all departments assessed. This breadth is strategically valuable, but it creates prioritisation and ownership problems. Interviewees reported that climate security concepts can require more detailed breakdown to address specific hazards, geographies, evidence streams, social vulnerabilities, time horizons, or thresholds. Climate security can therefore function as an effective agenda-setting concept that breaks down departmental silos, but needs tighter specification to guide decisions. As no one department owns the risk, it is a challenge to embed climate security into decision-making in a way that maintains urgency and enables action while still viewing the whole interconnected problem space in a systems framework.

The maturity of energy security

Energy security shows the highest narrative clarity across departments. It is consistently associated with supply, reliability, affordability, geopolitical exposure, and infrastructure resilience. It also incorporates facets of the clean-energy transition: domestic renewables, nuclear, critical minerals, demand reduction, and system resilience are now treated not only as decarbonisation issues, but as national security issues. This offers a benchmark for how less mature areas of the environment security agenda might be operationalised. (Note however that the energy security framework does not include all aspects of energy policy, and there can be tension between security, affordability and environmental goals.)



Environmental and nature security are emerging but underdeveloped concepts in government

Explicit reference to environmental security appears most in Defra and FCDO material. The concept of nature security is emerging related to the 2026 Global biodiversity loss report, new research funding and Natural England's strategy, but not yet in routine departmental language. Interview evidence suggests that the lower use of these concepts is not because nature or the wider environment is seen as irrelevant, but

climate, nature, and environmental risks are often strategic and even existential in scale but can be displaced by more immediate crises

rather that associated security implications are harder to communicate and route in policy-relevant ways. The concepts are often applied in specific policy areas, such as health, water, food, infrastructure, fiscal exposure, growth, and local resilience, long before any consideration of their national security relevance.

Postural divergence between hard security and resilience-oriented departments

Security departments tend to emphasise conflict, geopolitical exposure, operational and capability risk, borders, and migration. Environmental, scientific, and adaptation-oriented bodies tend to emphasise hazards, vulnerability, human and economic exposure, public health, infrastructure, natural capital, and resilience. The FCDO bridges both and uses threat-multiplier language to connect climate, conflict, development, and diplomacy. The divergence between hard security and resilience purviews is problematic when departments do not have a common method for responding to complex risks that cut across them.

While policy uses of the climate security concept have grown over the last five years, there is a trend towards deprioritisation in certain departments

This particularly affects those focused on hard security concerns. This almost certainly correlates to contractions in departmental budgets and diplomatic influences. Uses of the energy security concept have escalated significantly since 2022-23, due to the Russian invasion of Ukraine and its implications for UK oil and gas supply, and have remained at a high level with recent disruptions to oil and gas production and transport in the Strait of Hormuz. Use of the environmental security concept remains limited but has increased in Defra material since 2024.

These trends align with findings from the project's interviews with policymakers which similarly identified that there is a tendency for immediate crises to pull policy attention away from longer-term systemic risks. This is a core problem: climate, nature, and environmental risks are often strategic and even existential in scale but can be displaced by more immediate crises.

Therefore, it is essential to develop a different kind of prioritisation process: one that commits to integrating the downstream consequences and long-term costs of failure to act on environmental degradation, along with managing seemingly more acute issues.

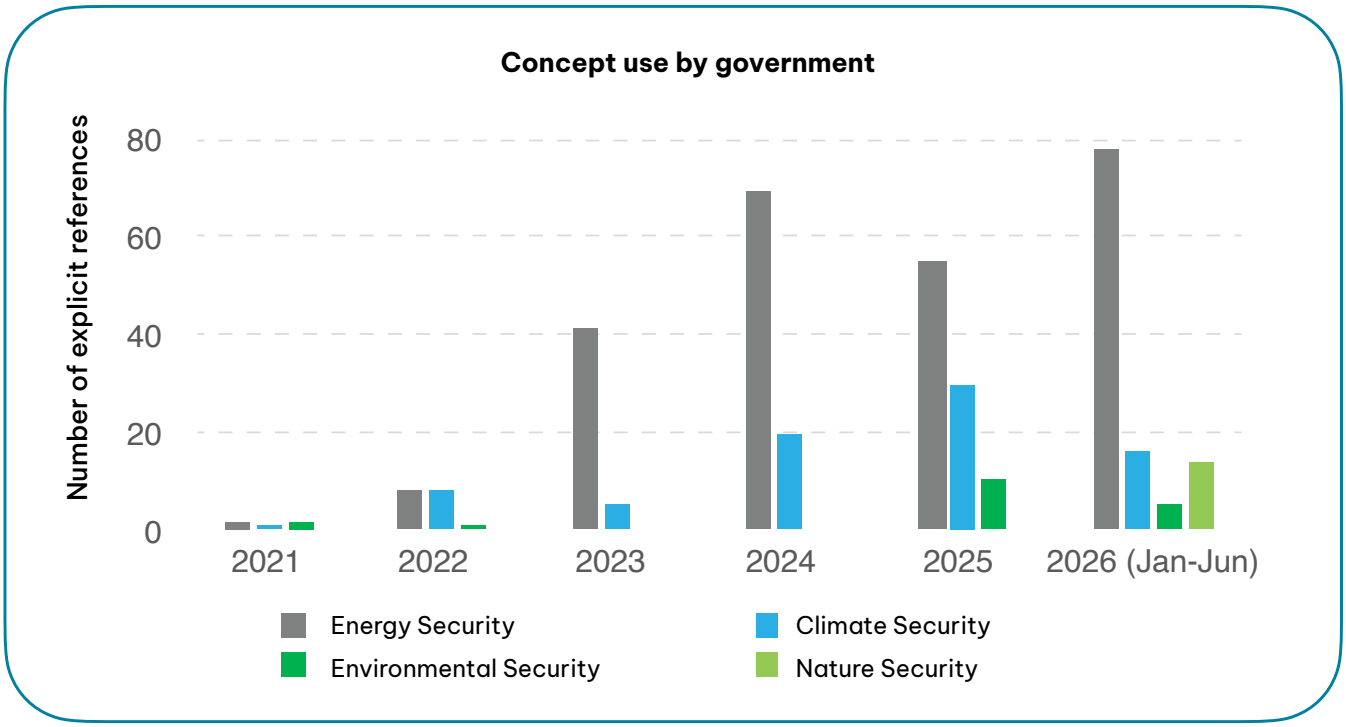


Figure 3. Changing use of environment-security terms in UK Government and departmental publications. Note: 2026 is only the first six months

3.6.Policy implications

The principal implication is that conceptual ambiguity is a practical constraint. While different framings can appeal to different audiences, and the most important issue is whether action is taken to reduce risk, different conceptualisations can obstruct policy action. Imprecision results in partial coherence, fragmented activity, and at times even policy paralysis. If departments do not share a consistent vocabulary for what environment, national security and other key terms encompass, opportunities for coherent response become more limited. This has implications for ownership, accountability and prioritisation as well as which risks are identified, data are collected, analyses are commissioned, partners are convened, and budgets are allocated.

There are six main risks from conceptual ambiguity.

1. Ambiguity creates blind spots

A narrow conflict framing may identify migration or instability but obscure upstream ecological, economic, and governance conditions. A narrow resilience framing may identify vulnerability and exposure but obscure geopolitical manipulation, strategic competition, or conflict pathways. A narrow economic framing may identify fiscal and productivity risks but obscure legitimacy, public safety, or international security consequences. Conceptual clarity enables layered policy analysis: from hazard to exposure; from vulnerability to governance; and from local resilience to national and international security response.

2. Ambiguity weakens prioritisation

Policymakers have limited bandwidth. Where boundaries are unclear, the system tends to default to the most immediate, measurable, and politically visible risks. Energy shocks, acute hazards, and border pressures are more legible than cumulative ecosystem decline or slow-onset resilience failure. This risks over-prioritising hazards that are easy to route and under-prioritising hazards that are harder to describe but strategically more consequential.

3. Ambiguity weakens accountability

A concept that is broad enough to attract agreement may also be too broad to generate action. Poorly bounded concepts can be useful for coalition-building but insufficient for decision-making. In policy terms, the issue is not whether the language is attractive but whether it clarifies ownership, evidence requirements, escalation triggers, and policy instruments. However, broad umbrella terms such as climate security can be fragmented into narrower subordinate terms, such as flood risk, coastal erosion and crop resilience, which can be linked through conceptual frameworks. Precise terminology is key and enables coordination across responses.

4. Ambiguity reinforces silos

Departments understandably respond to the parts of the environment security agenda that fit their mandate. That produces depth within departmental lanes but weak interoperability between them. The result is a system in which environment security may be understood simultaneously as conflict risk, development issues, energy-transition issues, resilience challenge, scientific-services problem, and economic concern. These are all valid, but to enable a coordinated response they should optimally be connected through a common routing model. Different departments will focus on their own priorities, but delivery should be coordinated to avoid different departments undermining each other by failing to see the "big picture", ignoring opportunities for multiple benefits, and risking trade-offs with other areas.

5. Ambiguity can undermine prevention

If the system only recognises environment security risks once they emerge as instability, infrastructure failure, price shock, displacement, or emergency service demand, it will predispose policy towards downstream management. Much of the strategic value of environment security analysis lies upstream: identifying where environmental stress, vulnerability, exposure, and governance weakness are converging before they become acute security problems and, in turn, enabling pre-emptive intervention.

6. Conceptualisation and reconceptualisation can serve as a drag to policy response

For example, whilst climate security and energy security are different, the recent shift in departmental prioritisation towards energy security has seen personnel and budgets repurposed. Interview data also indicated that, whilst climate security elements are apparent in the current energy security purview of certain departments, these are narrow and, in some cases, increasingly peripheralised. For example, focus on energy transition, force sustainability and defence capabilities, whilst crucially important for military stakeholders, is too limited to confer insight into the implications of energy supply and demand issues on societal and environment processes. Awareness of the remits and policy work of respective concepts mitigates some of these risks. Practically, if the same governmental resource is being redeployed from climate to energy portfolios, the scope of government response is being contracted.

Managing conceptual ambiguity is important and will inform more action. However, as other sections of this report make clear, it must be part of a package of enhanced communication, ownership, accountability and prioritisation of risk response.

4. Critical natural infrastructure

Humans depend on healthy, biodiverse ecosystems to deliver essential goods and services, including food, water, oxygen, a habitable climate, and protection from flooding and erosion. Access to nature also directly supports human health and wellbeing.[19] The concept of Critical Natural Infrastructure therefore highlights the importance of protecting, restoring and enhancing our vital natural assets, alongside investment in other critical infrastructure such as transport, energy and hospitals.[20] It has also been suggested that Global Systemically Important Natural Systems should be identified and protected in the same way as Global Systemically Important Banks because they are 'too big to fail' – further degradation would risk undermining the global economy and financial systems.[21]

The evidence synthesis report on Critical Natural Infrastructure[3] summarises some of the main security risks of nature loss, listed below.

- Tropical forests and oceans play a key role in controlling global carbon dioxide levels, and further damage to these critical ecosystems increases the risks of passing climate tipping points, such as changes to ocean currents, with severe consequences for the viability of crop production in the UK.

- Tropical forests also play a key role in generating rainfall in critical food production regions, including the La Plata basin in South America which supplies most of the UK's soy imports for livestock feed.

- Wild pollinators are declining globally, threatening the production of fruit, vegetable and oilseed crops that are critically important for human health and local economies. Pollinator loss also threatens all ecosystems that include flowering plants, trees and shrubs. Natural pest predators are also in decline, leading to higher dependence on costly pesticides.

- Food security in the UK is vulnerable to climate change, with much of our high-grade agricultural land being at risk of floods, droughts and sea-level rise, and imported food also threatened by climate change and pollinator loss overseas.

- Urban green spaces play a crucial role in climate resilience, especially through providing cooling, shading and flood protection, but are being lost to development.

There is already strong evidence to show that urgent action is necessary to protect and restore the critical ecosystems which underpin our food and water security, socio-economic prosperity, geopolitical stability and national security. Further research is needed to improve our understanding of the complex natural and socio-economic systems that affect critical natural infrastructure, but this should not delay immediate action to halt further environmental degradation and tackle key risks.

In the following sections, priority areas for future research are grouped into six broad areas:

Developing the evidence base and systems modelling

Action to support critical natural infrastructure

Understanding and monitoring critical natural infrastructure

Adapting to impacts

Valuing critical natural infrastructure

Policy and decision-making

Relevant policy areas

The research topics in this theme are relevant for a wide range of government departments including the Cabinet Office, the Climate Change Committee, Department for Business, Innovation, Science and Trade (DBIST), Defra, DESNZ, Environment Agency, FCDO, HM Treasury, Marine Management Organisation (MMO), MHCLG, MOD, and Natural England.

4.1. Evidence and systems modelling

To help with prioritising limited resources, there is a need to synthesise relevant evidence and present it in a form that can be used by decision-makers. We have identified the following potential research areas.

R1.1 Build the evidence base on the links between the environment and natural security

The links between climate change and national security are reasonably well understood, but there is less understanding of the links between biodiversity, ecosystems and national security. While the evidence synthesis report[3] explores selected high-priority issues, this could be expanded to cover other areas, including evidence on the co-benefits of including nature recovery in overseas development funding. The project team started to compile evidence on the links between each component in the causal pathways into a database, and this could be extended and linked to causal pathway diagrams to provide an evidence-synthesis tool for policymakers, and/or used to inform systems mapping and modelling.

R1.2 Develop a systems mapping and modelling framework

The links between environment and national security are complex. A systems mapping and modelling framework (building on existing tools and approaches)[22] would enable analysis and visualisation of cascading risks, interlinkages, feedbacks and emergent properties. This can help to inform a whole-of-government approach involving conversations across multiple departments, to reduce siloed working. It can help to ensure that actions are informed by a good understanding of potential co-impacts in other areas, leading to more robust decision-making. For example, it can help to align climate and biodiversity policies to avoid or limit undesirable impacts of climate policy on ecosystems.

R1.3 Analyse cascading risks to ecosystem functions

Systems maps and models can be applied together with literature reviews and expert input to explore which factors amplify or suppress cascading risks to ecosystems and their functional responses, and how analysis of these cascading risks can be used to design interventions.

R1.4 Prioritise the most critical ecosystems

Policymakers need to identify the biggest threats and the most promising opportunities for action, both globally and in the UK, while retaining the whole system approach. For example, the evidence synthesis report highlighted the critical importance of tropical rainforests (especially in the Amazon and Congo basins), ocean ecosystems, pollinators and pest predators, and high-grade farmland. Further research could expand this analysis and prioritise specific policy interventions to protect and restore critical assets.

4.2. Understanding and monitoring critical natural systems

Although there is a vast amount of existing research on how ecosystems underpin vital services, important questions remain (e.g. on tipping points, and the impact of biodiversity loss on carbon stored in oceans). There is also an urgent need for systems and indicators to monitor ecosystem condition and inform targeted action to prevent further degradation.

R1.5 Understanding the biological carbon pump

There is high uncertainty over the role of the biological carbon pump in contributing to ocean carbon storage and sequestration, how this might change in future, and the impact of multiple pressures on ocean ecosystems. For example, more research is needed to understand nutrient fluxes in marine animal food webs and how they will change under future climate conditions, including the impact of warming on diatom productivity,[23] and the impact of overfishing of keystone species, such as krill. Ongoing research in this area (e.g. OceanICU) needs to be monitored and used to inform UK policy.

R1.6 Measuring CO_2 levels in the ocean

Monitoring changes in surface concentrations of CO_2 in the ocean is essential for understanding what is happening to the ocean solubility pump, which currently absorbs 29% of manmade CO_2 emissions, yet the authors of the Global Carbon Budget[24] are very concerned that the number of measurements taken has been declining.

R1.7 Increase understanding of global tipping points

Further modelling and analysis are needed to understand and monitor the risk of passing critical tipping points, and the associated impacts, including for collapse of the six ecosystems identified in the UK Government report on global ecosystems and national security, and the implications for carbon cycles and future climate projections.

R1.8 UK ecosystem tipping points

Which UK ecosystem tipping points are most plausible, and how would the resulting state changes alter the likelihood/severity of acute risks in the National Risk Register (NRR)? This would explore whether full consideration of nature-related risks would affect the risks listed in the NRR, which shapes many areas of UK policy. The NRR addresses most non-malicious risks on a five-year timeframe, but in 2025 it also included chronic risks such as climate change, biodiversity loss and environmental degradation. There is a need to address relationships between chronic environmental risks and other acute risks, e.g. via systems maps, tipping points and thresholds.

R1.9 Develop methods to measure ecosystem health and condition and assess the impact on ecosystem services and resilience to change

This would go beyond the typical focus on a few iconic ecosystems or protected areas to consider the importance of the wider network of all UK habitats and green infrastructure, including overlooked features such as verges, scrub, small habitat patches and urban green spaces. What are the chronic risks to nature, e.g. from slow declines in soil health, pollinators or climate change? What interventions are needed to build resilience?

R1.10 Nature risk stress test

How could a 'national nature risk stress test' be operationalised to identify hotspots based on vulnerability (exposure, sensitivity and adaptive capacity)? This would be equivalent to financial or climate risk stress testing, broadened out to apply to nature-related risks. This could address the following research questions:

- **Scenario analysis**: How would the UK fare under different scenarios of nature loss and degradation?
- **Vulnerability hotspots**: Which areas are more exposed and/or vulnerable to nature-related risks and should therefore be prioritised in policymaking?
- **Critical systems**: Which social and economic systems or infrastructure are most exposed to risk because of the state of nature, e.g. financial institutions, pensions, critical national infrastructure, communities (e.g. from flooding), the health service, etc.?

R1.11 Interacting drivers of nature loss

How do we consider interactions between the five drivers of nature loss (pollution, habitat loss, invasive species, climate change and overexploitation) in assessments of ecosystem risk? Where and in which ecosystems are these interactions associated with cascading and compounding risks, and/or tipping points? This will build on the Natural Capital risk register produced in the State of Natural Capital report,[25] which assessed risks for individual drivers but noted a research gap on whether the risk ratings might change if interactions between drivers are considered. It could include consideration of compounding risks from multiple pressures, cases where one driver causes another, tipping points, and other systemic risks.

R1.12 Actionable environmental indicators

for security and resilience planning. This would:

- **Assess existing indicator frameworks** (e.g. state of natural capital, ecosystem service delivery indicators, protected area assessments, indicators of ecosystem function, Environmental Improvement Plan indicators, Nature Positive metrics, Taskforce for Nature-related Financial Disclosure (TNFD) metrics) and extract those relevant for nature security and resilience planning.
- **Determine whether additional indicators are needed to assess nature security risks.**
- **Identify key indicators of tipping points and early warning systems** across different broad ecosystems, by considering the most critical components for national security in a particular area (e.g. this could include risks related to sea level rise in the Fens, but also risks to critical global ecosystems)
- **Determine thresholds that should trigger action**, e.g. changes in management or intensive intervention.

R1.13 Plausible pathways for nature security impacts

What are the most plausible pathways from ecosystem degradation to adverse impacts on critical systems (e.g. water, energy, transport, food)? This is aimed at communication and storytelling of impacts and risks. Natural England is working with partners in workshops to identify possible pathways but need evidence to determine which of these pathways could occur under a "plausible worst-case scenario", in line with the approach used in the NRR which already identifies some acute environmental risks. As it is not possible to fully quantify all these risks due to the inherent uncertainty of natural systems, a blended approach to evidence-gathering would be needed, e.g. using literature, modelling and expert input. The aim would be to develop plausible pathways from ecosystem degradation to knock-on effects in different sectors (e.g. water, energy, food) that have relevance to policymakers in other departments.

4.3. Valuing critical natural infrastructure

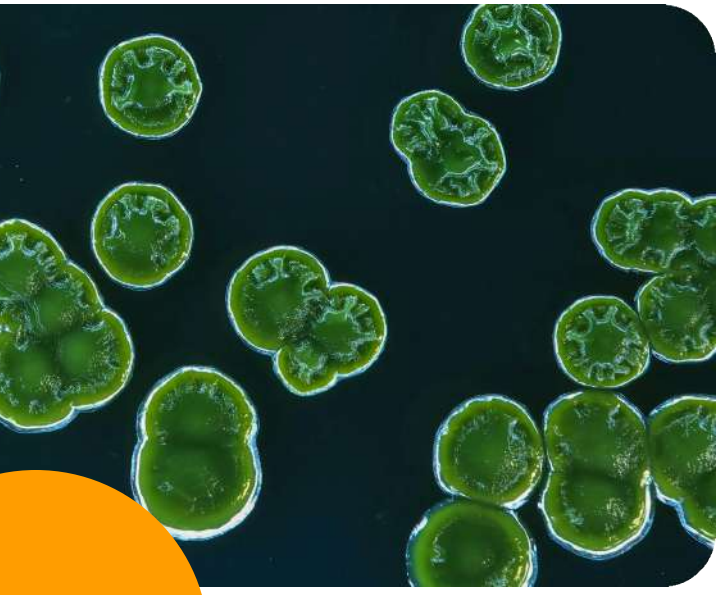
Natural infrastructure is undervalued in policymaking, partly due to difficulties in quantifying ecosystem services in monetary terms. Some research priorities are flagged below.

R1.14 Economic value of pest predators

While pollination services have been widely studied, the economic value of pest regulation provided by natural enemies remains underexplored.[26]

R1.15 Blue carbon habitats

These include; mangroves; seagrass; saltmarsh; macroalgae; and seabed sediments. More evidence is needed to develop, verify and monitor blue carbon projects and their impact on biodiversity and carbon, to unlock investment in preserving and restoring these valuable habitats.[27]



R1.16 Quantifying nature-security impacts

How can the adverse impacts of nature-related risks on national security be quantified, including through non-monetary valuation? There is ongoing research on how to include the value of biodiversity in the Treasury Green Book for assessing spending decisions, but this is challenging because the value of nature is highly context-dependent. There could be value in also considering how to integrate non-monetary value such as physical and socio-economic impacts, e.g. number of houses flooded, percentage of people in food poverty, or increase in food prices.

This topic addresses one of Natural England's "Areas of Research Interest": What are the most critical impacts of biodiversity loss and ecosystem collapse at different scales in terms of societal resilience, health and wellbeing outcomes and economic stability?

R1.17 Beyond GDP

Related to R1.16, measures of progress need to go beyond economic indicators to include human welfare and flourishing, which depends on environmental quality. There is considerable existing research on alternative measures of GDP, so the main question is what are the barriers preventing this from being mainstreamed into policymaking?

4.4. Action to support critical natural infrastructure

This section identifies high-priority research needed to support key policy recommendations on the practical measures needed to protect, restore and enhance critical natural infrastructure, both in the UK and in countries hosting ecosystems with global importance for UK national security.

R1.18 Nature-positive pathways

How can the UK support low-income countries towards equitable nature-positive pathways that balance immediate needs with protecting globally important ecosystems?

R1.19 Coral reefs and other marine animal forests

Research is needed into effective restoration strategies.[28]

R1.20 Improving yield from agroecological practices

Most agricultural research has focused on improving yield from intensive agricultural practices, but more research is needed on improving yield when applying more sustainable farming practices that enable reductions of fertiliser and pesticide use.

R1.21 Practical tools to support integrated pest management

There is a demand for user-friendly on-farm tools, for example, for integrating farmland trees into integrated pest management,[29] which require underlying research and evidence.

R1.22 Accelerating the circular economy to support national security

Shifting to a circular economy approach can tackle multiple pressures on critical ecosystems and reduce UK vulnerability to global resource shocks. Examples include:

- Further technical research on recovering critical metals from waste streams (including obsolete military equipment).
- Behavioural and policy research to address institutional inertia, policy silos and behavioural issues that are slowing down the transition to a circular economy.
- Smart fertilisers: developing more tailored fertiliser products from animal and human waste, to replace damaging broadscale slurry applications.

R1.23 Sustainable diets and supply chains

Shifting to more plant-based diets is a key tool for adjusting to potential loss of high-grade farmland in the UK, as it reduces the area of grazing land and feed crops needed to meet dietary demand. It is also vital for reducing pressure on critical global ecosystems, especially the Amazon rainforest where deforestation is largely driven by beef[30] and soy production. The UK is a major importer from the region,[31] and as the Amazon Soy Moratorium is collapsing,[32] it will become harder for UK firms to source deforestation-free soy for livestock feed. However, the essential dietary shift to more plant-based food would have major implications for farming communities. Social, behavioural and political science research involving extensive co-production with relevant communities is therefore needed to explore how this can be compatible with a just transition. Research is also needed on how to robustly eliminate commodities that have been produced through deforestation, forest degradation or unsustainable fishing practices from UK supply chains.

R1.24 Monitoring the effectiveness of nature-based solutions

Long-term monitoring is needed to assess the effectiveness of nature-based solutions for addressing flood and drought risk, including inland natural flood management, coastal managed realignment, agroecological practices to build soil health, and threats from sea level rise and subsidence in fenland areas.

Shifting to more plant-based diets is a key tool for adjusting to potential loss of high-grade farmland in the UK, as it reduces the area of grazing land and feed crops needed to meet dietary demand.

4.5. Adapting to impacts

As well as tackling problems at source by protecting and restoring critical natural infrastructure, there is an urgent need to adapt to impacts that are already happening. This is already addressed in other documents including the Climate Change Risk Assessment and the National Adaptation Strategy, so this section only focuses on two key priorities: risks to UK agriculture, and risks to local climate resilience through loss of urban green and blue space.

R1.25 Adapting agricultural production to climate change

How can UK agriculture adapt to both chronic and acute climate risks, including heat, drought and flooding, and potential serious climate change related to a slowdown of the AMOC ocean current and other tipping points? What would this mean for selection of future crop and livestock breeds?

R1.26 Monitoring the impacts of planning policy on the provision of urban green and blue infrastructure for local climate resilience

Recent (2024-26) and proposed future changes to planning policy in England recognise the importance of urban green and blue space for health, resilience and local economies, and require planners to consider Natural England's Green Infrastructure Standards or local equivalents.

However these policies do not effectively protect existing green and blue space from development, and do not mandate the provision of any specific quantity or quality of new green or blue space in new developments.[33] This is exacerbated by recent and proposed new exemptions to the Biodiversity Net Gain scheme,[34] meaning that many developments (especially in urban areas) no longer have any incentive to avoid loss of existing habitats or to create new habitats to compensate for loss and damage.

Research is therefore needed to monitor changes in provision of green and blue infrastructure in the UK, understand how this is linked to planning policy, and develop joined-up strategies to help policymakers balance housing and infrastructure development with the urgent need to strengthen climate resilience, including though impacts on human health and social cohesion (see Section 9.3).

4.6. Policy and decision-making

While the sections above focus on compiling and analysing evidence to support policymaking, this section addresses the need for simple tools and frameworks to help policymakers make sense of this information, balance different goals, prioritise the most urgent needs, and incorporate this knowledge into the decision-making process.

R1.27 'Planetary boundaries' for the UK

What would the national equivalent of 'planetary boundaries' look like for Britain, and how could they be assessed? This could consider the Doughnut Economics approach, which has been carried out for individual countries and at sub-national level (e.g. counties or protected landscapes[35] in England) via local Doughnut Economics labs.

R1.28 Priority UK ecosystems

Which broad ecosystems in the UK provide the greatest measurable risk reduction benefits (via ecosystem services), and to what extent are these services themselves at risk? This would build on the Global Biodiversity Loss report,[2] which identified the six most critical global ecosystems, and compile an equivalent list of UK ecosystems by type and geographic area. It would consider:

- Suitable indicators to help with prioritising risks (see R1.12).
- The ability of UK ecosystems to buffer from the effects of global climate and environmental impacts, including via the use of nature-based solutions for mitigating risks.
- Spatial variations in risk, e.g. not all upland areas face the same level of risk.
- Which ecosystems are in good state or degrading state.
- Where resources need to be invested to take early action to address a potential decline, or to increase buffering capacity.

R1.29 Nature for UK resilience

What role does nature play in risk mitigation for domestic resilience? This is linked to the identification of priority UK ecosystems (R1.27), but takes a smaller scale view, focusing on the specific details of using nature-based solutions and critical natural infrastructure to adapt and build resilience to global risks. It would consider:

How to use the State of Natural Capital report[25] alongside the Global Biodiversity Loss report[2] to inform assessments of UK nature security.

How to scale up the use of NbS as alternatives to grey solutions, by addressing the perceived lack of evidence on the cost-effectiveness of NbS compared to grey solutions amongst relevant stakeholders (including the infrastructure industry). This would also consider limitations on cost-benefit assessment of grey infrastructure options that excludes nature-related impacts and risks.

How to build the evidence base to inform the next National Adaptation Plan, which will move from discrete risks to a systems approach, opening up the potential to integrate nature-related risks and opportunities more effectively.

R1.30 Embedding critical natural infrastructure in decision-making

This builds on three of Natural England's "Areas of research interest":

How can we grow understanding of nature as Critical National Infrastructure and embed natural capital in development decisions to improve nature and wider economic and environmental outcomes?

What evidence do financial systems need to fully account for the value of nature when making investment decisions?

What are the most effective ways to embed nature into broad policy areas across wider government policy, such as education, health, and culture, to drive systemic and transformative change?

I**ntegrating flood policy with food security**. How does current flood policy address risks of food security? For example, how does this affect decisions for the long-term future of areas of significant agricultural production such as the Fens or East Yorkshire? This would consider the following points:

- At present, the criteria for determining the economic case for flood defences balance the cost of flood defences against the cost of damage to infrastructure or lost agricultural production from flooding. However, this is based on the current situation, typically informed by actual flood damage costs from the most recent year. It does not consider whether long-term environmental and geopolitical changes (e.g. to climate, national food security, soil health, fertiliser costs, water availability) might change the functionality of the land.

- Research is therefore needed to assess how the functionality of land at risk of flooding might change in future due to these other factors, and how these future changes might inform cost-benefit analysis and decisions on flood protection or adaptation strategies. For example, if the productivity of the land is expected to decline due to climate change, soil degradation or saline intrusion, then the economic case for protection would be weaker, but if future food security risks to the UK were projected to increase then the economic case for protection would be stronger.

- The research should consider the combined effect of multiple hazards and functions, including both drought and flooding. It could include expanding the current narrow success factors based on the cost of flood damage to consider multiple dimensions of success, including measures of food security such as the cost of food or the percentage of food that is imported, to see if that would change the flood investment decision.

R1.31 Integrating flood policy with global risks.

To what extent do policy outcomes on value for money and flood risk reduction preclude management of external (global) risks? For example, a high percentage of UK imports currently arrive at certain ports such as Immingham, so damage from a tidal surge would not only include direct costs to infrastructure but also to the functioning of the whole UK economy. However, this is not covered by the success measures currently used for decision-making – it can only be taken into account as a narrative. These issues need to be integrated into decision-making and future-proofed.

For example, how would the cost-benefit analysis for a specific port change if melting of Arctic sea ice opened up new shipping routes? (see also Section 6 and the accompanying report[36]). There is a need to set common metrics to assess these issues across government, as they go beyond the remit of just the Environment Agency and Defra. This will require common metrics and targets.

R1.32 Trade-offs between food security and water resources

If we need to increase UK food and manufacturing to mitigate global supply risks, there would be increased pressures on environmental quality, water quality and water resources. How would trade-offs be managed to ensure UK environmental security under that scenario, given the potential conflicts between very different outcomes such as food production, water resource constraints and biodiversity (e.g. impacts on fish if rivers run dry[37]). What are the cascading or compounding risks and the alternative mitigation options?

R1.33 Trade-offs between industrial strategy and water resources

How would the global risks described limit our ability to achieve growth across the eight key UK Industrial Strategy sectors? Are there any sectors that are particularly important to UK environmental security? This could consider, for example, the impact of data centres on water resources,[38] and competition between sectors (e.g. data centres needed for AI, water needed for manufacturing, food production, household use[39] and biodiversity).

R1.34 Impacts of droughts on national security

Under a drought scenario, what are the water resource priorities to maintain effective UK national security? How would resources be allocated between households, food production, energy production, data centres, industry and water needed to maintain river flows for biodiversity? What are the impacts on communities, education, health, transport, growth, etc. and how are these impacts connected to national security?

R1.35 Security implications of the end of flood re-insurance

"Flood Re" is a scheme where everyone pays a small premium on their house insurance in order to reduce premiums for those in high flood risk areas. To what extent could the planned end of Flood Re in 2039, and consequent uncertainty in the insurance market, lead to issues of financial insolvency and associated impacts on socio-economic prosperity and infrastructure? Flood Re was intended as a temporary measure to allow time for houses in flood risk zones to be made flood-resilient and for market forces to provide an alternative sustainable insurance option, but this has not happened. The National Planning Policy Framework in England still allows houses to be built in flood risk zones, provided that there is a physical escape route from the property, but this does not tackle the associated financial costs and risks of repeated flood events and uninsurable properties. Independent academic research is needed to examine the emerging impacts on property values and mortgage applications in flood risk areas, and the combined consequences for the finance and property sectors, and socio-economic impacts if large numbers of houses become uninsurable and unsellable (given that 25% of houses could be in flood risk zones by 2050).

R1.36 Impact of financial pressures on societal resilience

Evidence shows that financial pressures can increase vulnerability to hazards, by limiting revenue-funded activities for improving hazard readiness. Optimum resilience is achieved when relevant people and organisations (including local authorities, NGOs, companies, households, etc.) have the resources needed to learn about the risks and available options for adapting or coping, and are capable of acting on that information when needed. However, ongoing pressures due to the cost of living and reduced budgets mean that people have less money, time, energy and enthusiasm for receiving and acting on this information. For example, many people do not have flood insurance. How do financial pressures for both institutions and those at risk to natural hazards limit the extent to which we can achieve whole societal resilience?

R1.37 Tensions between ecosystem integrity, green economy, crime and conflict

Ecosystems are under threat from unsustainable extraction of raw materials, including critical minerals and biomass needed for green energy[40] and biomaterials, and fuel and water needed for data centres / AI. This can fuel geopolitical conflict and illegal extraction, providing revenue for hostile actors and organised crime groups. It is important to understand how environmental crime and degradation feeds conflict systems across the world and contributes to further climate, social and environmental disruptions, and what can be done to address this.

5. Resource management: food and energy demand

Sustainable management of natural resources is vital both for reducing impacts on critical natural infrastructure and for reducing the impacts of potential future resource shortages on national security. This project focused on managing food and energy demand, including the demand for related resources such as critical minerals and water (see the separate evidence synthesis report),[41] to reduce overall natural resource degradation, but some wider resource management issues are also considered.

This section first presents research gaps for food and energy systems separately (sections 5.1 and 5.2) and then considers research related to integrating the food and energy systems, breaking down silos to maximise benefits and reduce trade-offs (section 5.3). Although not covered in detail here, broader research on sustainable resource management is also urgently needed. This includes research to drive forward the circular economy, in order to reduce demand for raw materials and thus reduce both supply chain risks and environmental impacts (see section 4.4, R1.22). More research is also needed to understand how to deliver the behavioural and institutional change needed to shift to sustainable consumption patterns and thus achieve security for energy, food, water and materials.

Relevant policy areas

The research topics in this theme are relevant for a range of government departments including the Cabinet Office, DBIST, Defra, DESNZ, the Department of Health and Social Care, the Environment Agency, HM Treasury and Natural England, as well as industry and farming businesses.

5.1. Food system research agenda

Food literacy of the UK population

There are growing calls for food package labelling of environmental impacts[42] but the potential effectiveness of such a measure is limited by a low level of environmental food-systems literacy across the UK population.[43] While consumers generally understand what a healthy diet consists of, less than half know what a *sustainable food system* consists of. Consumers frequently underestimate the impact of their diets[44] and struggle to translate awareness of sustainability issues into informed food choices. [45] Consequently, experts emphasise an urgent need to embed comprehensive food systems education in schools to promote long-term food and sustainability literacy.[46] This prompts the question:

R2.1 **What educational measures could lead to an improvement in food literacy?**

And, in the shorter-term:

R2.2 **What policy mechanisms and interventions can successfully adapt to the public's current level of understanding to drive meaningful and sustainable dietary shifts?**

Changing food demand to mitigate health and environmental impacts

A research and action agenda, co-developed with the food sector business and policy communities, needs to integrate food production and processing, diets, non-food uses of agricultural and fisheries products, food loss and waste, and food system governance. Collectively, a coordinated set of relatively small improvements in each factor on the demand side of the equation will lead to a significant reduction in overall demand, but these need to go beyond provision of information to tackle the deeper motivations behind current choices and barriers to more sustainable alternatives.

R2.3 **How can we bring about a change in demand for foods which are less healthy and which also have a high environmental impact?**

Reconciling coordinated governance with localised thinking

UK food policy requires national coordination, but the literature also advocates for polycentric governance, where bodies operate with autonomy reflecting local geographical, ecological, and socioeconomic dynamics.[47] Greater local autonomy should better support initiatives – such as food hubs and action networks – that build social resilience. These are highly context-dependent, requiring sufficient citizen agency to succeed. A key research challenge is identifying how policy can embed participatory decision-making into national strategy.[48]

R2.4 **How can coordinated, collaborative governance at a national scale enable sufficiently localised solutions without losing their contextual relevance and agility?**

Integrated food policy emergency planning

This theme considers how to develop an integrated food emergency plan.

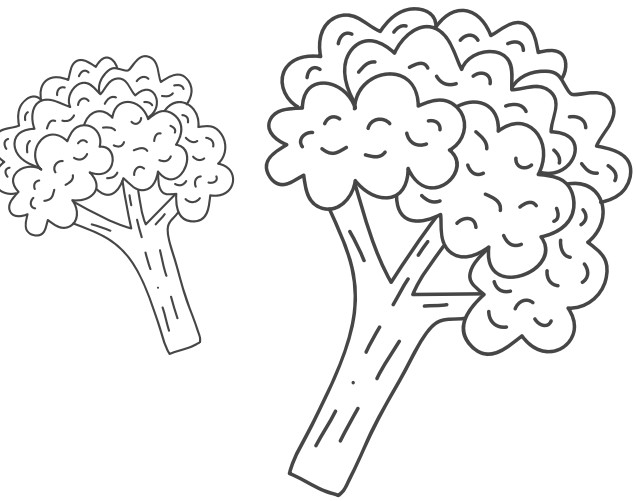
R2.5 **How to coordinate across different governmental and non-governmental actors in case of food emergencies and decide on who does what?**

R2.6 **What are possible long-term measures needed to support food system resilience measures and how to evaluate their impacts on different food system outcomes?**

Shifting diets

To meet the UK's greenhouse gas (GHG) emissions targets, the Climate Change Committee recommended to reduce current meat and dairy intake by 20% by 2030.[49] Animal products have significant higher carbon emissions and land and water footprints than plant-based food. A shift towards plant-based diets, rich in fruit and vegetables, nuts and wholegrains would also reduce the risk of mortality and chronic disease morbidity, including cardiovascular disease, cancer and type 2 diabetes.

R2.7 **What can lead UK consumers to adopt a 20% reduction in red meat and dairy consumption by 2030 to reach net-zero goals, while increasing the intake of pulses, fruits, and vegetables?**



Reducing food waste

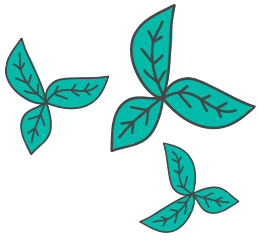
WRAP estimated that in 2021, total food waste in the UK amounted to 10.7 million tonnes (Mt).[50] By weight, most food waste comes from households (60%), followed by farms (15%), manufacturing (13%) hospitality and food service (10%) and retail (2%). Food waste releases methane from its breakdown in landfill and through waste of the energy and resources required to produce wasted food.

R2.8 **What are the environmental and economic trade-offs when reducing food waste and how can these best be negotiated?**

Stability of yield increase

The UK cereal yield gap is the significant difference between actual farm yields and the theoretical maximum genetic potential. While UK wheat and barley have theoretical potentials of 19 and 16 t/ha respectively, increases in average farm yields have stagnated, hovering around 8 t/ha for wheat and 6 t/ha for barley. As this means UK cereals achieve only 50–60% of their actual genetic capacity, narrowing this 'yield gap' remains a critical target for UK food security and farm profitability but it needs to be done without further environmental degradation.

R2.9 **How can the UK balance higher agricultural yields with environmental and economic stability for both producers and consumers? This is related to R1.19, Improving yield from agroecological practices.**



5.2. Energy system research agenda

Conceptualising energy as a national security issue reveals crucial knowledge gaps for the future resilience of the UK. The following outlines five key areas that research might contribute to as part of a secure energy transition.

The changing nature of energy security

The shift to renewables necessitates an order of magnitude increase in reliance on critical natural minerals, which changes the nature of energy security. For example, a typical electric car requires six times the mineral input of a conventional car.[51] As we displace fossil fuels with renewable electrification, the focus of energy security policy changes from direct supply of energy, mainly fossil fuels, to securing the ability to produce energy via the technologies, metals and minerals needed for this new infrastructure. This has implications for national security, as the increasingly concentrated nature of critical mineral markets in a few nations[52] could lead to market volatility and supply constraints, posing a risk to energy security.[53] Further security risks could arise from geopolitical conflict over resources and choking of supply by competitor nations.

R2.10 How does the changing energy landscape affect energy security?

R2.11 What level of access to critical minerals and other materials and technologies is essential for clean energy security?

R2.12 What choke-points exist in global critical mineral supply chains for the UK?

R2.13 How can a circular economy approach help to reduce reliance on imported critical minerals and other materials, including by re-manufacturing or recycling end-of-life components? (see also Section R1.17)

Grid resilience and future energy systems

The electricity system will undergo a series of important qualitative changes as we progress towards the necessary electrification. The increasing presence of renewables, and the increasing demand for electricity from heat and transport and the increasing threat from a changing climate will all affect the electricity grid into the future.[54] Grid modernisation will be essential to ensure energy security and pass on the benefits of a renewable system to citizens. This will involve managing flexibility, long term storage and interconnectors. An energy system based primarily on renewable energy needs storage at all timescales from microseconds to multi-year.[55]

Renewables are essential technologies for realising climate goals and decarbonising energy, but they require trade-offs in terms of added pressures on the natural environment. These pressures cannot be ignored – they need to be included into planning and scenario modelling for the ongoing transition.

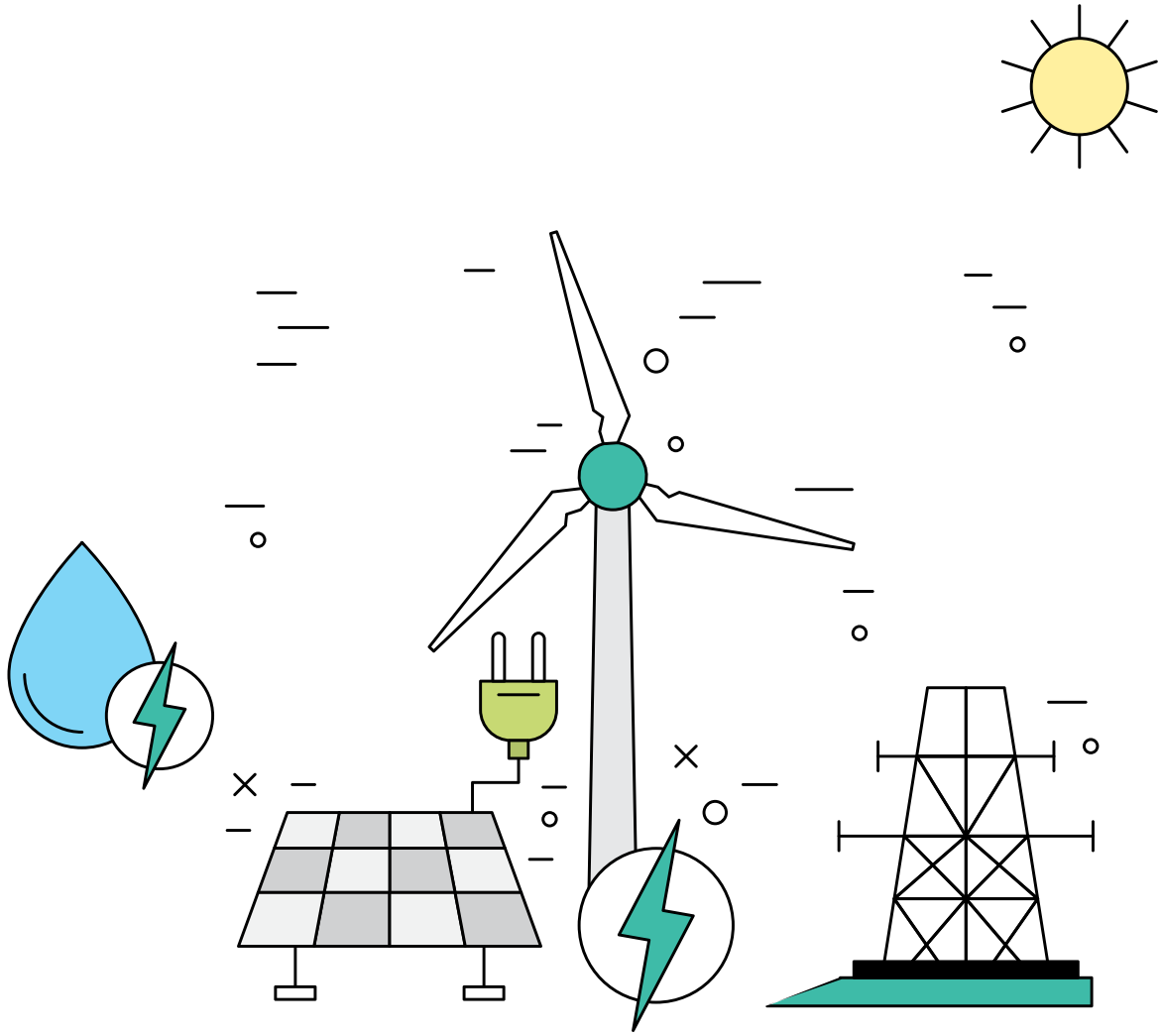
The ability to plan and work in an ecologically considerate way is currently hampered by knowledge gaps and scientific uncertainties.[56] New methods and data from the dedicated monitoring activities around off-shore wind energy developments will be essential to overcoming these gaps.[57]

This will be highly valuable to policymakers, managers, decision-makers and industry as we push ahead with the decarbonisation of energy.

R2.14 What are the risks inherent to grid modernisation?

R2.15 What are the best options for meeting energy storage needs at different timescales, especially inter-seasonal and multi-year storage?

R2.16 What data and methods gaps exist to fully track the ecological impact of expanded renewables, and to develop methods for avoiding or minimising these impacts?



Decommissioning

As our energy system shifts away from fossil fuels, the existing infrastructure for fossil fuel extraction and exploitation will need to be gradually descaled and decommissioned, while methods need to be developed to deal with new infrastructure. This presents two key challenges for future research.

Managing infrastructure decline in an ecologically sensitive manner.[58] As well as responsible decommissioning of fossil fuel infrastructure, important questions remain to be asked about construction, ongoing maintenance and the circularity of decommissioning for new renewable infrastructure.

Social and economic impacts of infrastructure decline – especially the gas network in the UK. Improper management of this will result in acute problems for those who are late to disconnect, as network charges could surge due to fewer consumers sharing the costs of upkeep. Improved coordination will therefore be needed between renewable heat planning and gas infrastructure.[59]

R2.17 What considerations are necessary to centre the environment in the decommissioning of fossil fuel infrastructure, to protect critical natural infrastructure from damage?

R2.18 What would a social justice-oriented departure from gas in the UK look like?

Innovative governance

Certain aspects of the transition to clean energy will require new ways of working and policymaking. Some of these requirements are likely to challenge the existing modes of governance[60] many of which evolved with fossil fuel infrastructure.[61] For example, moving past simple insulation measures to necessary, but more complex, whole-house retrofit measures, has proven difficult for traditional policymaking.[62] As transitions progress and more courageous policy is increasingly necessary, research into how innovations in governance might accelerate this transition and nurture new approaches will be essential.

R2.19 What governance changes are necessary to facilitate policy to manage energy demand?

Energy waste

Fossil fuels are very inefficient and wasteful technologies. Eradicating energy waste as we electrify will result in far lower energy demand.[63] The inherent efficiency of an electrified system coupled with less wasteful lifestyles will alleviate the overall environmental pressures of the expanding energy system.

R2.20 Where and how can waste be eradicated throughout the UK energy system?

R2.21 What are the limits of relying on technology alone to reduce energy waste? And how can energy sufficiency compliment this?

5.3. Integrated food-energy research agenda

Demand reduction policies

Meaningful demand reduction requires changes to current consumption patterns. Research is needed to understand how best to communicate advice on both food and energy demand reduction to households, and how to encourage use of energy and food to be sufficient for given needs while avoiding 'rebound effects' that might otherwise erode potential savings.

R2.22 How can behavioural science approaches such as choice architecture or dynamic social norm appeals be used to encourage reductions in food and energy use while avoiding political or cultural backlash?

R2.23 How will the public in the UK react to more radical sufficiency-oriented policymaking?

R2.24 What is the optimum balance between regulation and freedom of choice for demand reduction to minimise natural resource degradation?

Calorie consumption effect on energy demand

All food system activities require energy, so reducing food over-consumption will reduce energy demand. Calorie consumption in excess of physiological need is a major contributor to obesity, so reducing over-consumption will have significant health benefits. This will affect overall energy demand but the mechanisms, and hence the optimum points of entry for reduction of over-consumption, are not clear.

R2.25 To what extent will a reduction in calorie over-consumption and a shift towards more plant-based foods affect energy demand and what are the mechanisms by which this will happen?

Integrated scenario planning

An integrated scenario planning exercise is needed to synthesise understandings of the climate vulnerabilities and resilience of a better integrated food and energy system across the UK.

R2.26 How can the understanding from the conceptual framework developed for this project (see the evidence synthesis report on managing food and energy demand)[41] be mapped into future scenario planning?

Water-energy-food (WEF) nexus

The project has highlighted the need for better integration of the food and energy systems, but literature increasingly calls for water as a third critical pillar.[64] Agriculture uses roughly 70% of global freshwater, requiring substantial energy to extract and treat, while water is itself essential for energy generation.[65] Water shocks can cascade across the food-energy system,[64] making an integrated WEF nexus essential for moving beyond siloed management.[66]

There are significant vulnerabilities in the UK WEF nexus.[65] UK food manufacturing is water-intensive and highly sensitive to energy prices,[67] while worsening droughts affect domestic agriculture.[68] The UK imports most of its fruit and nearly half its vegetables, predominantly from water-stressed countries like Spain, Morocco, and Egypt.[69]

R2.27 To address these vulnerabilities, future research must prioritise demand-side strategies to mitigate WEF impacts on supply chains.[66]

Combined agriculture and energy planning

Physical space in the UK is limited, and there could be conflicts between the needs of the food and energy systems for space in the future as we pursue climate goals, such as through deployment of NbS or renewable energy. Combined research about how land sharing can occur and where synergies and trade-offs need to be negotiated will be essential for managing these rapidly changing systems. For example, this could include consideration of planning policy changes needed to fully protect high grade farmland from development, or implementation land-sharing options such as agrivoltaics (growing crops or grazing livestock between the panels in solar farms).

R2.28 What are the conflicts and opportunities for land-sharing between renewables and agriculture?

5.4. Broader food and energy security issues

Although the main focus of this project was on managing food and energy demand, further research gaps related to food and energy security were identified.

R2.29 What are the global food security implications of different future geopolitical scenarios, e.g. dominance by different world powers, including control of chokepoints and supply chains for fundamental commodities?

R2.30 What are the implications for food security if global food production shifts geographically (e.g. northwards) in response to a changing climate?

R2.31 What would be the impacts of a rapid transition to war on food, water and energy security in the UK?

R2.32 How can advanced energy performance, resilience, and innovation be integrated as key components of UK military readiness and operations, including integration of renewable energy options such as solar panels to reduce reliance on heavy diesel generators?[70]

6. Shipping and UK trade

Shipping plays a key role in UK national security - 98% of imported goods (by value) arrive by sea - but it is becoming more exposed to climate hazards and energy transition challenges.[36] Melting of Arctic sea ice also brings new risks and opportunities. This project explored key vulnerabilities and cascading risks for UK supply chains, and recommended interventions to enhance resilience (see the evidence synthesis report on shipping and trade), but it also identified an urgent need for more research to map these dependencies in greater detail.

The research agenda is grouped into five themes: climate risks to ports, maritime chokepoints, Arctic trade, Arctic policy, and decarbonisation of shipping. A final section suggests a prioritisation for urgent, medium-term and longer-term research based on the criticality of the information gap, urgency, likely cost and effort, policy impact, and geographic or system scale.

6.1. Resilience and adaptation of ports to climate risks

This theme covers climate impacts on ports that are important for UK trade, both in the UK and abroad. Existing evidence shows that ports already face compound climate hazards, with sea-level rise becoming an issue in the longer run. These hazards can disrupt port operations, with impacts cascading through trade networks. The remaining research gaps are more specific: which ports are most critical to UK supply chains, which vulnerabilities matter most for continuity of service, and which adaptation measures would reduce spillover risk at lowest cost?

Policy importance

Improving understanding of the impact of compound hazards on ports and their associated logistics systems will help to reduce uncertainties around the cascading impacts of climate hazards and identify where intervention would have the greatest payoff.

Relevant policy areas

Department for Transport, FCDO, Cabinet Office, port authorities, devolved administrations, regulators, insurers and infrastructure owners.

System interdependence and propagation

R3.1 **How do ports depend on other infrastructure sectors**, such as rail and road networks in the ports' hinterlands, or power and telecommunication networks, and how do (compound) hazard impacts propagate through this inter-connected system, and over what timescales?

R3.2 **Contingent business interruptions:** How can disruptions affect clusters of ports in the same region and how can they generate ripple effects on the wider logistic chain in which that cluster of ports is embedded, over what timescales?

Spill-overs into the UK

R3.3 **Which UK-critical foreign ports are most exposed to (compound) climate hazards and which are most important for UK imports?**

R3.4 **Which ports carry goods that are hard to replace, reroute or stockpile?**

R3.5 **How do spillovers from foreign ports propagate into domestic UK supply chains**

R3.6 **Which cargo types, lead times and substitute routes matter most?**

R3.7 **What level of disruption causes real loss of service?**

Adaptation

R3.8 **Which adaptation measures give the greatest resilience gain per pound spent?**

R3.9 **How do ownership and regulatory structures affect the speed and quality of adaptation?**

Methods

R3.10 **How can the accuracy of compound risk assessments of infrastructure be improved (e.g. by empirically deriving multi-hazard impact response functions or multivariate vulnerability curves)?**

R3.11 **Incorporate time-dependent recovery pathways in impact analysis of compound climate hazards.**

6.2. Maritime routes and exposure to chokepoints

Maritime routes connect UK ports to ports around the world, often passing through maritime chokepoints – strategic and narrow passageways. Chokepoints are exposed to both conflict and environmental risks (e.g. the Panama Canal is exposed to droughts). Here, we identify research gaps around maritime chokepoints and their relevance for UK national security.

Policy importance

Disruptions at chokepoints can cascade into delays, rerouting, higher costs and shortages, affecting food, energy and defence-related imports. This is of particular importance to UK national security as our trade depends on a small number of maritime chokepoints.

Relevant policy areas

DBT, FCDO, Cabinet Office, Royal Navy, Met Office.

R3.12 How will UK and global trade networks, and trade exposure at maritime chokepoints, evolve in the future?

R3.13 How do changes in demand affect route choice, freight rates and exposure along key maritime corridors?

R3.14 How do correlated hazards or simultaneous disruptions across regions affect global shipping networks and UK exposure to risk?

R3.15 Which critical goods imported into the UK are exposed to seasonal constraints, recurrent congestion or limited alternative routes?

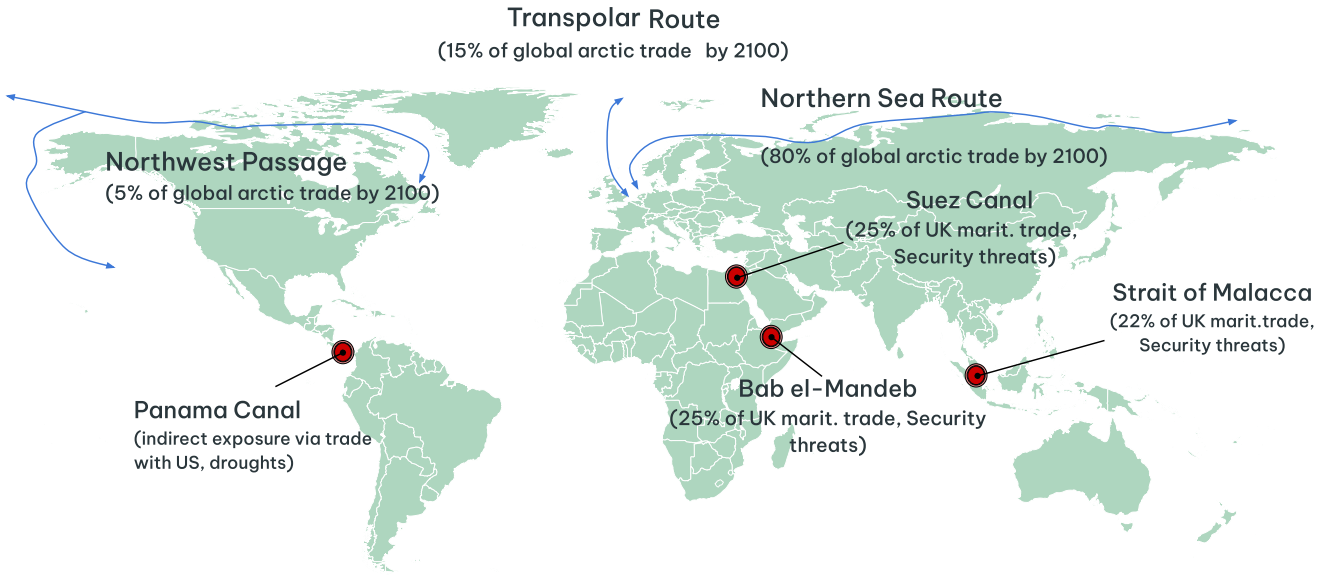


Figure 4. Global chokepoints and Arctic routes.

6.3. Arctic trade, routing, infrastructure and resilience

Arctic sea-ice decline may open new seasonal trade routes as alternatives to routes via the Suez Canal, Bab el-Mandeb and Panama Canal. However, it is an open question whether shippers would actually use these new routes, under what conditions, and what infrastructure would be needed to make them workable. A first estimate of the share of global trade that could be re-routed via the three Arctic routes (classified by vessel type and industry) was carried out for this project[71] but more detailed analysis is required.

In addition, more information is needed to understand the risks to Arctic shipping from drifting ice, severe storms, poor visibility, limited mapping of water depth, rapidly changing weather conditions, and limited forecasting capacity.[72] Accidents in the Arctic can be severe due to the remoteness and limited capacity for emergency response.[73] For example, in 2018 an expedition vessel struck the seabed in poorly charted waters, stranding 160 passengers and crew in a remote area of the Canadian Arctic.[74] Incidents such as this can cause cascading economic impacts through supply chains and the insurance sector. Maritime insurers estimate that a major Arctic shipwreck could cost USD 1 billion due to the need to tow specialised equipment long distances in unpredictable seasonal windows.[75]

Policy importance

Whether Arctic routes remain niche or become strategically relevant has major economic, infrastructure and security implications. This research would help to show whether Arctic shipping is a real diversification option or another source of concentrated risk.

Relevant policy areas

Department for Transport, DBT, FCDO, Maritime and Coastguard Agency, insurers, shipping firms, port authorities, UK Hydrographic Office, HM Treasury, infrastructure planners.

R3.16 **Under what fuel prices, insurance conditions, seasonal windows and ice conditions would firms switch to Arctic routes?**

R3.17 **What support infrastructure would be needed for any scale-up: ports, bunkering, icebreakers, hydrographic data, communications, repair, salvage and emergency response?**

R3.18 **How would traffic in the Arctic change in the case of disruption at a vital maritime chokepoint (e.g. Panama Canal)?**

R3.19 How can we gain a quantitative understanding of risks in the Arctic? This could include:

- How do the risks around Arctic routes translate into additional costs?
- What is the sensitivity of key cost variables used to model Arctic trade, including typical vessel costs, vessel size, fuel costs, ice-breaker costs and insurance premia?
- How can we predict the likelihood of Arctic navigation incidents,[76] identify risk factors,[77] and estimate adverse outcomes such as the cost of emergency response and repair in remote conditions, the economic impact from cascading effects through supply chains, and the environmental impact on coastal communities?
- How should Arctic route uncertainty be built into shipping, insurance and resilience models?

R3.20 What role might mining, oil and gas extraction, and other resource development play in driving Arctic shipping demand?

R3.21 Which non-Arctic routes, ports or operating adjustments could absorb diverted trade if Arctic routes are unavailable, too risky or too costly?

R3.22 What monitoring indicators would tell policymakers that Arctic routes are becoming commercially or strategically significant?

6.4. UK-Arctic policy frameworks

Arctic sea-ice decline has environmental, social, security and military implications for the UK that will need to be addressed. Increased shipping raises the likelihood of cumulative impacts from air emissions, greywater discharge, bilge waste, and accidental pollution events near sensitive coastal ecosystems. The International Maritime Organization's Polar Code established mandatory safety and environmental provisions for ships operating in polar waters, but several Arctic policy studies argue that additional regulatory measures and monitoring systems may be necessary as traffic continues to expand.[78] Quantifying environmental impacts can help inform such regulations.

The geopolitical dimension further adds to the complexity and uncertainty of navigating the Arctic. Questions surrounding sovereignty, military access, information sharing, and jurisdiction become particularly sensitive because the region is increasingly viewed as strategically important for trade, energy development, and national security. There is a need for research to understand the intertwined factors influencing the geopolitics in the Arctic including climate change, uncertainty about oil and gas exploration, and the power dynamics among Indigenous communities.[79]

Policy importance

These gaps are important because a route can look efficient on paper but still impose high environmental and social costs, making this a central question for policy legitimacy. Similarly, if commercial routes depend on strategic competitors or disputed waters, apparent efficiency may hide exposure to coercion, sanctions or escalation.

Relevant policy areas

FCDO, DESNZ, DEFRA, Ministry of Defence, Cabinet Office, NATO-related planning, Arctic allies, legal and maritime policy teams, regulators, environmental agencies, Arctic research institutions, Indigenous partners.

Environmental and social implications

Arctic shipping may reduce distance, and thus emissions, but that does not mean it reduces overall environmental harm. It is an open question how emissions savings compare with pollution, spill risk, ecosystem damage and climate feedbacks.

R3.23 **How do emissions savings from shorter Arctic voyages compare with the emissions costs of slower speeds, ice-class vessels and support logistics?**

R3.24 **What are the likely impacts on black carbon, underwater noise, wastewater, ballast water and spill risk?**

R3.25 **What are the consequences for coastal communities, ecosystems, and Indigenous livelihoods?**

R3.26 **How do shipping impacts interact with albedo loss, sea ice decline and possible longer-run climate feedbacks?**

R3.27 **What is the likely scale and cost of response to spills or accidents in remote ice-covered areas?**

Military and security implications

Arctic shipping is not just a commercial issue. It is increasingly entangled with sovereignty, military access, surveillance, border management and strategic competition.

R3.28 **How would rising Arctic traffic affect sovereignty claims, jurisdiction and freedom of navigation disputes?**

R3.29 **What are the implications of Arctic shipping for the security posture of Russia, China, NATO allies and the UK?**

R3.30 **How would dual-use infrastructure, military ports or support facilities affect commercial routing decisions?**

R3.31 **Which UK military ports, naval bases and support facilities (and those in other countries relevant to UK supply chains and security) are most exposed to flooding, storm surge, heat, overtopping and cascading infrastructure failure?**

R3.32 **How resilient are the access routes, fuel systems, communications, repair capacity and logistics chains of these vulnerable facilities under compound climate hazards?**

R3.33 **What are the implications of Arctic shipping for UK and allied security, especially in the High North and North Atlantic where Russia is investing heavily in defence infrastructure?**[80]

R3.34 **What governance gaps exist if traffic grows faster than institutions, rules and response capacity?**

R3.35 **What are the implications for the UK's wider High North, North Atlantic and NATO security interests?**

R3.36 **How can serious games and decision models be used to quantify Arctic geopolitical risk and its impact on global policy?**

6.5. Energy transition

The energy transition is not only a shipping-fuels issue. It also affects the geography of supply, the resilience of ports and the demand profile of maritime trade. As global warming increases cooling demand and reshapes industrial and food systems, supply chains may become more energy-intensive in some places and more localised in others. The research gap is therefore not just which fuels will be used, but how the transition will reshape routes, hubs, infrastructure and dependencies, including the role of green ammonia as a likely low-carbon fuel pathway.

Policy importance

The energy transition is vital to reduce emissions but can also create new dependencies. The policy challenge is to align fuel change, port adaptation and environmental protection so that decarbonisation does not generate new chokepoints or damage the natural systems that support fisheries, carbon storage and coastal resilience.

Relevant policy areas

DESNZ, DEFRA, DfT, port authorities, regulators, industry and environmental agencies.

R3.37 **Climate change and global warming may increase energy demand for supply chains due to higher cooling requirements (especially for food). How will supply-chains adapt, and can shorter, localised supply chains reduce energy demand?**

R3.38 **How concentrated will the fuel supply chain become, and how dependent will the UK be on a small number of import routes, hubs and suppliers?**

R3.39 **How does port construction, dredging and fuel infrastructure interact with coastal habitats, fisheries and carbon stores? This is especially important where decarbonisation and resilience measures might damage mangroves, saltmarsh, seagrass or reefs.**

R3.40 **Which UK ports are most likely to become bunkering or fuel hubs, and what adaptations will they need first?**

R3.41 **How can military interoperability with civilian infrastructure be ensured (e.g. compatibility of military ships with commercial ports), including through compliance with environmental legislation?**

6.6. Suggested prioritisation

Tier 1: urgent, high-impact, feasible within 6–18 months

- *Which ports and port-linked dependencies are genuinely critical because the goods they carry are hard to replace, reroute or stockpile? (R3.4)*
- *What level of disruption causes real loss of service, and what indicators would warn of emerging failure? (R3.7)*
- *Which shippers and cargoes would actually use Arctic routes, and under what fuel prices, insurance conditions, seasonal windows and ice conditions? (R3.16)*
- *Quantify the main environmental, spill and geopolitical risks around Arctic routes. (R3.19, R3.24-27, R3.29, R3.33-35)*
- *Which indicators would show that Arctic routes are becoming strategically important? (R3.22)*

Tier 2: medium-term, requiring deeper analysis

- *How do disruptions propagate through interconnected systems, including hinterland roads and rail, power, telecoms and clustered ports? (R3.1, 3.2)*
- *Which adaptation measures give the greatest resilience gain per pound spent? (R3.8)*
- *How concentrated will the low-carbon fuel supply chain become, and how dependent will the UK be on a small number of import routes, hubs and suppliers? (R3.37)*
- *What support infrastructure would be needed for Arctic scale-up, and which non-Arctic alternatives could absorb diverted trade if Arctic routes are constrained? (R3.17, R3.18, R3.21)*
- *How should Arctic route uncertainty be built into shipping, insurance and resilience models? (R3.19d)*

Tier 3: longer-term strategic

- *How will Arctic governance evolve as traffic grows, and what role should the UK play in standards, monitoring and international coordination? (R3.34)*
- *What are the climate feedbacks associated with increased Arctic shipping? (R3.26)*
- *How will mining, oil and gas development alter shipping demand and infrastructure needs? (R3.20)*
- *How do port construction, dredging and fuel infrastructure interact with coastal habitats, fisheries and carbon stores over the longer term? (R3.38)*

In conclusion

The most important research gap is not only whether the Arctic is opening, but what that means for trade, infrastructure, environmental risk and security across the wider maritime system. A forward-looking agenda should help policymakers understand when Arctic shipping is a useful option, when it is not, and how it interacts with ports, chokepoints risk, decarbonisation and wider supply-chain resilience.

7. Downstream migration response

Concerns around the 'downstream migration response' relate to the perceived security challenges arising from the increased mobility of people moving across the planet due, in part, to environmental change. This is often described as 'climate migration' and it is commonly assumed that most of those involved are international migrants.

Two qualifications of this common understanding are in order. First, over a century of migration research has shown that movements over short distances are much more frequent than over long distance – a phenomenon known as distance decay. This also holds for climate migration. Studies using different methodologies and data have shown that climate migration, amplified by planetary urbanisation, will be directed first and foremost towards cities in the country where people live, or towards cities in neighbouring countries. The idea that climate migrants from global South contexts could arrive at the UK's borders in large numbers is speculative, but is sometimes mobilised for political purposes and to stir anti-migrant sentiments. While there will be some climate-related migrants to the UK, they are most likely to arrive as part of diasporas, in particular those linked to the UK's colonial history, plus some of the approximately five million (mostly "white") UK citizens currently living abroad.

Second, other living organisms are also on the move. In the Anthropocene the habitual separation of human society from the natural world is increasingly untenable, with growing recognition of the entanglement of the human and non-human often captured through the notion of the "more-than-human". Since the rise of European colonialism in the 15th century, capitalism has greatly extended and accelerated the circulation of people, material objects, plants, animals and diseases, which are spread across the world through contemporary agro-industrial complexes, trade and tourism. Changes to climatic conditions mean that pathogens such as viruses, bacteria, fungi and parasites as well as vectors like mosquitoes and ticks can survive and flourish in new places, posing new and sometimes serious threats to human and animal host populations, public and environmental health, and local economies.

These issues prompt three themes for further research on climate-related mobilities:

International migration of people – here the significance of diasporas, rooted in British colonialism, takes centre stage, as well as the fact that areas at great risk of environmental degradation related to climate change may map onto regions that have historically, again mostly in the context of colonialism, seen substantial out-migration towards the UK. An additional complication in security terms is that radicalisation is more common among a small share of people with family histories of migration from some of those former colonies.

Domestic mobilities of people – if human migration is inversely related to distance, then climate migration within the UK can reasonably be expected to increase in the coming decades. Much of this may take place as part of 'managed retreat', or the purposeful and coordinated movement of people, infrastructure, and assets away from areas vulnerable to hazards like sea-level rise and flooding. This has particular relevance in parts of the UK vulnerable to rapid coastal erosion and in densely populated river catchments such as the Thames's, where flooding is a major personal and insurance risk.

More-than-human mobilities – here attention is broadened to the dynamics in the interconnected movements of people, animals, plants and pathogens; the conditions that facilitate or hinder those mobilities; and the actual and potential responses by the UK Government and its agencies.

7.1. International migration

Key questions raised by policy stakeholders under this area of the project recognise that international climate migration may be linked to UK national security directly via diasporic links to the UK and the arrival of migrants in the country (R4.1-4.2) and indirectly by creating social and political tensions in places, and particularly cities elsewhere that attract large number of climate migrants (R4.3-4.5).

At the same time, the questions also recognise the opportunities that diasporic networks, and the resources that flow through them, offer to increase climate resilience in places and countries that are being affected significantly by climatic events (R4.6-4.9). These diasporic networks can be mobilised to channel and increase the efficacy of UK Government support.

Relevant policy areas

FCDO, the Home Office, MOD.

R4.1 **How are contemporary political movements and ideas shaped** by the shared experiences of migrants from nations with historical links to the UK that are now affected by climate change?

R4.2 **How do digital links between the UK and diasporic networks** of transnational television stations, online platforms and personal communications shape the understanding of climate migration in the UK, including the emergence and circulation of hostile or misleading narratives?

R4.3 **How might domestic and short-distance climate-related migration** in Africa, the Americas, Asia and continental Europe affect UK national security indirectly via increased risk of conflict, demand for humanitarian conflict and other mechanisms?

R4.4 **How can British development aid secure the liveability of cities of the global South in countries with historical links to the UK** by optimising the resilience of informal housing, economies and services like transport to climate change?

R4.5 **What are the implications of environment-related migration** for conventional understandings of externalities, common pool resources and property rights in cities of the Global South?

R4.6 **How do mobilities of climate related migration at different geographical scales impact public health risks rooted in the informal city?**

R4.7 **How are diasporic links and networks associated with downstream migration mobilised** to address the challenges of climate migration globally in nations with historical links to the UK**?**

R4.8 **How do UK diasporic networks channel climate adaptation finance and knowledge to vulnerable countries of origin** in Africa, the Caribbean, and South Asia? How could Commonwealth links across the Global North and South alike be formally integrated into climate diplomacy, ODA and adaptation finance architecture?

R4.9 **How does the circulation of diasporic remittances, as a major driver of global economic development,** interface with local responses to climate migration in countries of the Commonwealth and former colonial rule?

7.2. Domestic migration

The research questions under this heading concern managed coastal retreat in the UK, and specifically the scale and economic costs of the process (R4.10), how this process is influenced by policy discourse and insurance processes (R4.11-4.12), how it can be coordinated and managed when attention is not only directed towards local communities but also critical infrastructures (R4.13-4.15), how economic risks and environmental risks of flooding can be made commensurable and traded off (R4.16), how capacities to receive displaced communities can be identified (R4.17), and what fair distributions of the burdens and benefits of managed retreat might look like (R4.18).

Relevant policy areas

The Cabinet Office, Defra, the Environment Agency, MHCLG, and Natural England.

R4.10 **At what scale, where and when is managed retreat likely to occur?** What demographic groups are most at risk? What are the likely costs to the UK economy and the local economies of affected regions?

R4.11 **How does the policy discourse on current and future climate change risks and on managed coastal retreat** affect the decision-making of households, businesses and public and third-sector organisations as well as the local economies, collective wellbeing and sense of communities in areas that are considered to be at risk? To what extent and in what ways does that discourse generate self-fulfilling prophesies?

R4.12 **How can private insurance regimes in the UK incentivise optimised adaptation and mitigation interventions** that anticipate and enable, both shape and prevent, managed retreat in the UK?

R4.13 **What might a specific logic and associated actions and measures for the managed retreat of relevant critical national infrastructures look like?**

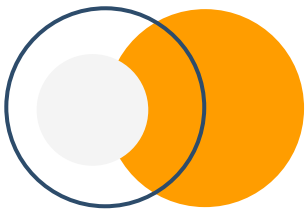
R4.14 **How might the managed retreat of local communities and critical national infrastructures deemed at risk be aligned and coordinated?** How should responsibilities for these different forms of retreat be assigned and coordinated, both at national government level and between national and local government?

R4.15 **How should a statutory compensation framework for managed retreat be designed,** including eligibility, compensation levels (capped vs market value buyouts), treatment of coastal erosion and flood risk, and integration with planning, housing needs assessments, and local council finance at destination locations?

R4.16 **How should economic risks (for instance in the densely populated Thames Gateway) and environmental harms be measured and traded against each other within the context of flood risk governance?**

R4.17 **How can the capacity of communities to receive and accommodate households, businesses and other organisations displaced due to managed retreat be identified? How and to what extent can participatory methods help to increase buy-in from receiving communities in that identification process?**

R4.18 **How can the financial and other burdens that local retreat will generate for receiving communities be shared fairly** across local authorities, between levels of government, and between public, private and third sector actors? How and by whom might this sharing of burdens be contested and what might the consequences of contestation be?



7.3. More-than-human mobilities

In the UK context, warmer and wetter winters are at least as important to the survival of pathogens and vectors as hotter and drier summers. West Nile virus, Xylella and the tiger mosquito may become established in the UK, while the geographical range and seasonal activity of vectors associated with Lyme disease and bluetongue virus may increase. The UK's extensive biosecurity arrangements and presence of the sea as a buffer offers additional protection. Inevitably, however, the UK borders remain permeable, and perhaps more so than those of other island states such as Australia or New Zealand. It will also be important to imagine and learn how to live with historically absent plants, animals and diseases, and how to manage the impacts they may have on public and environmental health.

The research questions in this category consider the patterns and future distributions of more-than-human mobilities (4.19), the ways in which those mobilities are shaped by and co-evolve with the circulations associated with trade, agriculture, tourism and recreation (R4.20), the potential role of some green and blue infrastructures as breeding grounds for invasive pathogens and vectors as well as offering numerous benefits to communities, country and local and transnational ecosystems (R4.21), fundamental uncertainties about what threats pathogens and vectors may pose with further climate change (R4.22), the implications of such pathogens and vectors becoming established in and diffusing across the UK (R4.23), and the challenge of finding ways of "living with" and managing hitherto unestablished pathogens and vector populations (R4.24).

Relevant policy areas

The Climate Change Committee, Defra, the Met Office, and Natural England.

R4.19 **What patterns of emergence and distribution of pathogens, vectors and hosts affecting One Health across the UK** at high spatial resolution can be expected at different moments in time and under different climate scenarios? How should this evidence base be integrated into the biosecurity surveillance and programmes of action led by Defra, the UK Health Security Agency and the Animal and Plant Health Agency?

R4.20 **What are the implications of changes in the domestic and international mobilities** associated with trade, agriculture, tourism and recreation for the circulation and distribution of pathogens and vectors that determine human, plant and animal risk in the UK?

R4.21 **How can the vital role of ecosystems such as wetlands as critical natural infrastructure, with benefits for individual and collective wellbeing, be reconciled with potential risks** of these areas supporting invasive pathogens and vectors such as mosquitoes, which could spread under climate change and threaten human and animal host populations elsewhere in the UK? How can any trade-offs between benefits and risks be assessed, managed, and mitigated? What might the UK be able to learn from research and governance of those trade-offs in other countries worldwide?

R4.22 **How can methods for generating radically different climate futures help biosecurity, One Health and border policies** to reimagine possible impacts of pathogens, vectors and hosts under conditions of further climate change in the UK? How might the insights thus generated inform quantitative modelling of future disease distributions?

R4.23 **What are the implications of diseases and invasive species that are most likely to become established and spread further in the UK as climate change proceeds** – e.g., West Nile virus, Lyme disease, bluetongue virus, and Xylella – for human, animal, plant and environmental health, as well as biosecurity practices at local and national levels?

R4.24 **How might local communities and the country at large learn to "live with" and manage the health and economic risks linked to hitherto non-established species and diseases becoming endemic and spreading across different areas in the UK?**

8. Weaponisation of Nature and Weather

There is a long history of the weaponisation of nature in all human civilisations that stretches back thousands of years and is well covered in existing research. But it is now urgent to think ahead to future scenarios and new forms of nature weaponisation, and how best to resist them.

Nature has been used deliberately and strategically to attack, coerce and defend. Enemies have been flooded, exposed to extreme weather, deprived of water, crops and food, and cut off from key natural resources by the strategic control of rivers, land, sea and sky. They have defended themselves in forests and with earthworks, tunnels, water courses and high ground. All armed forces have commandeered animals, crops, water and fuel into their military operations.

The natural environment has also been the collateral victim of human violence without being the main target itself. This is because war routinely destroys, degrades, and pollutes other life alongside human life whether military commanders intend to or not.

Studies on the weaponisation of nature, or environmental warfare, look more to the past than the future. Scholarship to date concentrates on the historical record of scorched earth; water weaponisation; deforestation; land and maritime chokepoints; weather warfare; biological warfare, and the exploitation of minerals, animals and natural resources in the financing of war. The literature is uneven. It is highly skewed towards water weaponisation, scorched earth and conflict minerals. It is also divided over definitions and boundaries of what constitutes environmental warfare, and whether nature has intrinsic value or exists for human control.

Scholars mark US deforestation and weather modification in Vietnam in the 1970s, and its international regulation in the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification (ENMOD), as the critical escalation point in the modern weaponisation of nature. Wars in Iraq, Ukraine, Gaza, Sudan and Iran are subsequent spikes. Nature is weaponised by non-state armed groups and government forces. Insurgents like Islamic State in Iraq and Syria (ISIS), the Revolutionary Armed Forces of Colombia (FARC), Hamas, and the Rapid Support Forces (RSF) are all strategists of environmental warfare.

Weaponising nature is likely to become a key strategy in hybrid warfare. Opponents can use environmental policy, chokepoints, or cyberattacks to deprive one another of natural resources, or use sabotage to poison water, start wildfires, or disrupt cooling systems in heatwaves and heating systems in winter.

The evidence synthesis report on the weaponisation of nature[81] found four important trends:

Nature is being weaponised more frequently today by a growing number of states and non-state groups.

The weaponisation of nature can cause dangerous and disastrous transboundary, cascading and (sometimes) irreversible harm to ecosystems, earth systems, and social cohesion, and impose high restoration costs in money and time.

Emerging dual-use technologies look likely to enable new forms of nature weaponisation and hybrid warfare.

UK Government policymaking, public discussion and international law lacks conceptual clarity and appropriate policy urgency.

These findings make it pressing for the UK Government and UK society to embark upon a detailed research agenda that gets the nation up to speed with risks and threats from the increasing weaponisation of nature in today's world.

This needs to address three core challenges:

- Embed conceptual clarity of risk and response across government and society
- Achieve a comprehensive understanding of the nature risks from hybrid warfare
- Establish a resilience plan to protect UK nature and nature-based supply chains.

This forward-looking research will help HMG to produce important conceptual, empirical, strategic, and governance analysis to inform new government policy on the weaponisation of nature and the UK's environmental security.

Relevant policy areas

Cabinet Office, Defra, Environment Agency, FCDO, Foreign Office, Home Office, Met Office, MHCLG, MOD, Natural England.

9. Conceptual consolidation, causal mapping, and risk typology

The UK needs a clearer concept and typology of the weaponisation of nature as the foundation for new policymaking.

New research should clarify precisely what the weaponisation of nature is and is not. It will also develop a clear causal theory of exactly how it impacts the UK in various ways. It will:

- set boundaries to the concept
- build a typology of causes, pathways and different forms of weaponisation
- calibrate the various impacts of environmental warfare across a spectrum of local, national, regional and earth systems effects.

This typology should also look at the different ways that law and policy can be used as "lawfare" and "polfare" to weaponise nature in international relations to achieve strategic advantage.

A central aim of this research is to develop a dashboard typology and evaluative criteria for HMG to assess intent, capability, impact, accountability, costs, and recovery trajectories around the weaponisation of nature. This includes a common framework for classifying environmental impacts according to their breadth, depth, duration, recoverability, cascading potential, and contribution to wider earth-system change.

Starting research questions could include the following:

R5.1 **What criteria distinguish the weaponisation of nature from other kinds of environmental harm, resource exploitation, infrastructure targeting, or collateral ecological damage?**

R5.2 **Which categories of natural resources – including water, animal life, vegetation, land, hydrocarbons, critical minerals, and other ecological assets – fall within the scope of nature weaponisation and why?**

R5.3 **Which forms of exploiting nature – including offensive, defensive, direct, indirect, strategic, covert, logistical, and revenue-generating uses – fall within the scope of nature weaponisation and why?**

R5.4 **Which instances of deliberate targeting or manipulation of critical national infrastructures reliant on natural resources (e.g., dams, nuclear power plants) fall within the scope of nature weaponisation and why?**

R5.5 **What are the risks of expanding the category of weaponisation too broadly, and what analytical value is lost if the category remains too narrow?**

R5.6 **How do biodiversity loss, ecological degradation, and Earth system tipping points shape contemporary weaponisation of nature?**

R5.7 **How can "lawfare" be used to produce permissive interpretations of environmental law and the laws of war, among others, in ways that normalise or enable the weaponisation of nature?**

R5.8 **How can "polfare" be used to set environmental policies that normalise or enable the weaponisation of nature?**

R5.9 **What are the varied effects of kinetic attacks on or covert sabotage of critical national infrastructure under the rubric of weaponisation of nature?**

R5.10 **How should accountability be assigned when nature weaponisation produces slow, cumulative, transboundary, or scientifically uncertain harm?**

9.1. The weaponisation of nature in hybrid warfare

There is a need to investigate the weaponisation of nature as an emerging strategy of choice in subthreshold and hybrid warfare. This is especially important in a period of rising climate-related opportunism for hybrid warriors to maximise suffering and deprivation during heatwaves, droughts, poor harvests, and political contest in the UK.

Research should focus on core aspects of this field to:

- Assess the evolution of nature weaponisation by disposable or deniable agents
- Identify disruption opportunities for hybrid warriors in new dual-use technologies like geoengineering, early warnings systems, water, food and energy supply
- Improve risk assessment and attribution tracking for nature weaponisation threats.

Starting research questions for this research strand include:

R5.11 **What is the history – in doctrine and practice – of how the weaponisation of nature has been conceptualised and applied in subthreshold and hybrid warfare?**

R5.12 **Why and how has the weaponisation of nature been used in 21st century subthreshold and hybrid warfare so far, and with what results?**

R5.13 **How do climate change, resource scarcity, and critical national infrastructure vulnerabilities create new forms of environmental opportunism in subthreshold and hybrid warfare?**

R5.14 **Which existing and emerging dual-use technologies (civilian technologies adaptable to coercive ends) make the weaponisation of nature more feasible and more likely?**

R5.15 **How does the development and diffusion of dual-use technologies (geoengineering, weather modification, life sciences, and biological engineering) alter the profiles and capabilities of adversaries weaponising nature**

R5.16 **How can emerging weather modification techniques (cloud seeding and solar radiation management) circumvent, supersede, or expose the limitations of the Environment Modification Convention and other international legal instruments pertaining to the weaponisation of nature?**

R5.17 **What strategic, scientific, and security trade-offs arise from investing in new dual-use technologies with potential for misuse, dual-use exploitation, and environmental harm?**

R5.18 **How can accidental threats be distinguished from deliberate weaponisation of nature in contexts where mis/disinformation obscure intent, attribution, and responsibility?**

R5.19 What indicators could be developed to identify nature weaponisation before it becomes overt or catastrophic?

9.3. UK resilience to weaponisation of nature

This research agenda would establish how the UK can better anticipate, withstand, and respond to the weaponisation of nature. It will work to a logic of "protect and prepare" and explicitly connect threat mapping with policymaking.

Research emphasis situates UK resilience within a wider planetary context, recognising that the gravest and most urgent risks may be transboundary and require international norms and coordination to prevent, mitigate, and restore.

In particular, this research would:

- assess the UK's national and planetary environmental vulnerabilities
- identify the capabilities required for national resilience, including preparedness for compound crises and the integration of environmental protection into defence planning
- gauge the legal prospects for effective accountability for deliberate environmental harm domestically and internationally. If necessary, recommending new types of crime.

Starting research questions for this research strand include:

R5.20 What are the UK's domestic and planetary environmental chokepoints (air, sea, land, critical infrastructure, and natural resources) that are particularly vulnerable to weaponisation?

R5.21 To what extent do existing UK policies on food, energy, and critical minerals already strengthen national resilience to conventional and emerging forms of nature weaponisation?

R5.22 What ecological, social, infrastructural, and institutional capacities should the UK develop or improve to deter, reduce, resist, and recover from the risks and effects of the weaponisation of nature?

R5.23 How can UK's whole-of-government and whole-of-society preparedness systems manage concurrent threats from the weaponisation of nature, as in the simultaneous occurrence of a food shortage, an extreme heat scenario, wildfire, and the deliberate targeting of water infrastructure by an adversary?

R5.24 What role might the diversification, protection and restoration of UK nature play in UK defence and resilience?

R5.25 How could ecocide be effectively incorporated into UK domestic legislation in a way that establishes clear tests for deliberate environmental harm and criminal liability, and remain coherent with existing frameworks of environmental law, criminal law, and international legal obligations?

R5.26 How can historical episodes of nature weaponisation inform risk assessment, conflict response, impact mitigation, and restoration efforts today?

R5.27 How can international law and legal cooperation mechanisms prevent and prosecute global, transboundary, and earth-system impacts of weaponising nature?

10. Societal resilience and mental capital

Societal resilience is the capacity of a society to resist, cope with, recover from, and adapt to shocks, stress, adversity, and trauma while maintaining the conditions that allow people, communities, institutions, and systems to function. Resilient societies can cope better with the impacts of environmental degradation such as floods, droughts, heatwaves and food price spikes, reducing the risks to national security.

Societal resilience depends on the interaction of mental, social, and economic capital: people and institutions are better able to cope, recover, and adapt when cognitive and emotional capacity, trust, cooperation, and material security reinforce one another. These enabling factors help people and governments to work together more effectively, both to adapt to resource shocks or extreme weather events and to tackle problems at source by protecting and restoring critical natural infrastructure, creating a positive feedback loop. However, this requires sustained investment in the mental, social, and economic foundations that allow people and institutions to function under pressure, including education, financial security, physical health, social cohesion, trusted institutions, and the quality of everyday environments.

Access to nature plays an important role in sustaining physical health, mental health, wellbeing, social connection, and resilience. This extends beyond formal parks or protected landscapes to include 'forgotten ecosystems': small, informal, or under-recognised spaces in and around where people live. Protecting and enhancing nature is therefore important not only for physical climate resilience (e.g. cooling, shading, flood protection, carbon storage) but also to boost mental and social capital and thus enhance community capacity to respond to climate stress.

Following on from the evidence synthesis report on mental capital and social resilience,[82] priority areas for further research are compiled under three key themes:

- understanding and monitoring societal resilience
- understanding how mental capital and wellbeing interact with environmental challenges
- understanding how nature can support mental capital.

Relevant policy areas

Cabinet Office, Defra, Department for Education, Department of Health and Social Care, Environment Agency, HM Treasury, Home Office, MHCLG, Natural England.

10.1. Understanding and monitoring societal resilience

This research theme aims to understand the conditions that deliver societal resilience, and how it can be monitored. In particular, further research is needed to assess how mental, social, economic, natural, and human capital interact to determine societal resilience, including through enabling processes such as trust, participation, co-production, and social learning. Key research needs are listed below.

R6.1 Build and test a model of how different kinds of 'capital' interact to shape societal resilience

Models are needed that can test whether different combinations of capitals predict stronger recovery after shocks. This will require strong definitions of each kind of capital and interrogation of relevant use cases. A UK place-based dataset could be developed to facilitate modelling, compiling factors linked to different kinds of capital; e.g. mental health outcomes, social cohesion indices, deprivation, housing quality, climate exposure, and community support infrastructure. Computational approaches could then be used to discover capital profiles that predict 'societal resilience' – defined as recovery, coping and adaptation to acute climate shocks and chronic environmental pressures, such as flooding, heatwaves, service disruptions, or economic downturns.

R6.2 Identify early-warning indicators of declining societal resilience

The framework in Figure 1 shows observable dimensions of social, economic, and mental capital that contribute to societal resilience; such as health and wellbeing, economic prosperity, social cohesion, rights and justice, institutional trust, and inequality. Additional research is needed to (1) identify how to use data on these dimensions to detect any decline in societal resilience; and (2) to know what dimensions to prioritise when making strategic decisions to enhance resilience and prevent further decline. The overarching research aim could be to provide a clear resilience dashboard for policymakers.

R6.3 Social cohesion during acute shocks

We do not know how social cohesion functions during acute shocks. Crisis-response case studies could test whether neighbourhoods with stronger cohesion show better preparedness, compliance with advice, mutual aid, recovery, and institutional confidence after disruption, drawing on UK measures such as the Community Life Survey[83] and local trust and civic participation data.

Complementary longitudinal case studies of communities exposed to repeated shocks (such as flooding, heat, or economic stress) could test whether mental distress, economic insecurity, and low trust compound over time, or whether interventions can reverse the negative pathway (an empirical test of the vulnerability feedback loop).

10.2. Understanding how mental capital and wellbeing interact with environmental challenges

More research is needed on how national mental capital and wellbeing intersect with environmental challenges, including toxins, climate change, and water and food security. The evidence synthesis[82] of existing literature on this topic (covering papers from 2020-2026) found a range of reviews, qualitative and cross-sectional data, but none focused on mental capital as the central topic, although individual components such as emotional regulation, executive functions and coping strategies were included.

Also, there are currently very few studies on this topic from the UK, as most of the current empirical evidence comes from regions of the world already experiencing high impacts from climate change and ecological degradation. These are valuable for learning about possible future impacts in the UK as climate impacts accelerate over the next few decades, but further UK-based research is also needed, particularly in vulnerable areas, alongside evaluations of nature-based interventions to inform long-term policy. We therefore propose the following recommendations for future research.

R6.4 Geographic area

Up-to-date empirical evidence is needed from across the UK, with special focus on regions that are more vulnerable to the effects of climate change, as well as communities in closer proximity to environmental contaminants.

R6.5 Socio-demographic focus

Global data shows a disproportionate burden on specific groups of people, such as children and adolescents, older adults, women, those with disabilities and people in climate-vulnerable industries/occupations. Future research should target such groups, i.e. be designed with an environmental justice focus, in order to assess if there are disproportionate risks/burdens to specific groups.

R6.6 Methodological considerations

Well-designed qualitative research allows an in-depth and rich understanding of subjective issues such as mental capital, mental health, and wellbeing; and cross-sectional studies are needed to generate the first level of evidence for more complex quantitative study designs to follow on. Furthermore, a well-designed cross-sectional study that takes potential confounding factors into account (e.g. pre-existing mental health conditions, socio-demographic variables etc.), can be cost-effective and can be feasible on a shorter timescale. However, since the literature shows the effects of chronic exposure to climate change and other environmental hazards on mental health and wellbeing, longitudinal studies are needed to understand the long-term effects of such exposures. Moreover, longitudinal studies also allow for causal inference while simpler study designs only present correlational evidence.

R6.7 Standardisation of definition

A clear conceptualisation of mental capital and how to evaluate it will be critical to any research done on the topic, especially if it is to be replicated in different contexts within the UK.

R6.8 Intervention research

More empirical evidence is needed through rigorous assessments of interventions that are indicated to have a protective effect on mental capital/health/wellbeing in the literature (e.g. access to green and blue spaces, embedding climate change education into curricula, etc).

Example research questions include

Which environmental exposures most strongly affect cognition, learning, productivity and mental capital across the life course? (This will determine research priority for toxins, pollution, extreme climate events, hazards, etc.)

Which occupations are most vulnerable to the effects of climate change and/or environmental degradation?

How are communities that are dependent on the land (e.g. farmers) affected by acute and chronic environmental stressors?

How do trust, social capital, participation and perceived fairness alter the wellbeing impacts of climate adaptation and environmental transition policies?

What indicators can government use to detect environment-related wellbeing risk early enough for preventive action?

How can nature recovery, green and blue infrastructure, food system resilience and pollution reduction be valued as mental capital / societal resilience investments?

10.3. Understanding how nature can support mental capital

The evidence synthesis report compiled existing research on how "forgotten ecosystems" beyond formally recognised parks and protected reserves can contribute to mental capital. [82] However, while policymakers can apply potential support mechanisms such as Biodiversity Net Gain, Local Nature Recovery Strategies, Green Infrastructure planning and natural capital accounting, they lack practical evidence on which habitats matter most for wellbeing, social connection, and community resilience. Further research is therefore needed to tackle evidence and knowledge gaps, so that the role of different forms of green and blue space can be fully understood, recognised and supported by policymakers and the public.

R6.9 Forgotten ecosystem literacy and engagement

Forgotten ecosystems often include patches of scrub, long grass, dead wood and wildflowers that can be perceived as "messy" or "abandoned" and in need of tidying, rather than being understood as valuable habitats that support insects, birdsong, cooling, water regulation, wellbeing, and resilience. Further work is needed to demonstrate the value of these habitats to policymakers and the public, and to develop effective strategies to support local communication, education, interpretation, citizen science, school engagement and community stewardship.

R6.10 Comparing benefits from nature in formal and informal spaces

Evidence on the role of green and blue spaces in supporting mental health and wellbeing evidence is relatively strong, but nature is often treated as a broad category. There are studies on individual aspects such as green space quality, birds, blue space, brownfield sites, pollinator health, soil biodiversity, scrub, and forgotten urban spaces, but there is a research gap on comparing benefits delivered by forgotten ecosystems with those from formal parks and protected areas. Further research could therefore assess outcomes such as mental wellbeing, attention restoration, perceived safety, social contact, place attachment, nature connection and emotional recovery across different forms of green and blue infrastructure, paying attention to habitat quality. This would allow local authorities to justify protecting or maintaining sites that may otherwise be overlooked or dismissed as low value.

R6.11 Biodiversity quality and sensory pathways

There is a need for more evidence on how different qualities of biodiversity deliver benefits for mental health and wellbeing, for whom and under what conditions. Research should examine whether the qualities people directly experience including soundscape, tree canopy, plant diversity, water presence, habitat complexity and perceived naturalness and care, predict mental capital outcomes more strongly than the amount of green space alone. It should separately test whether the

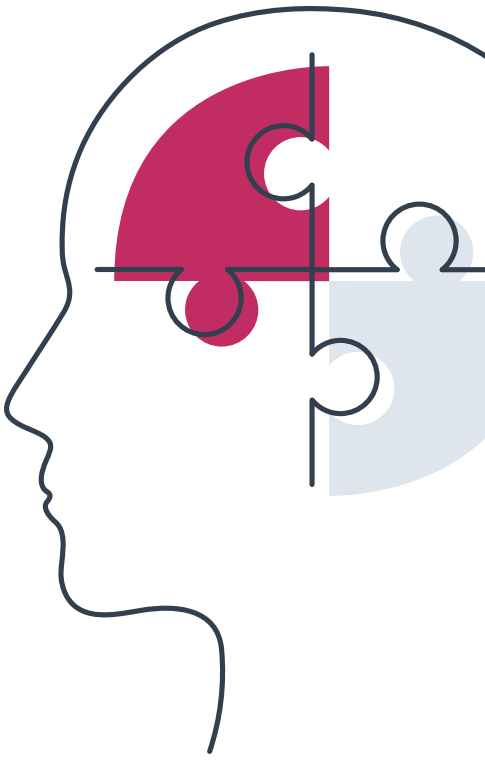
ecological foundations that sustain those ecosystem qualities, such as healthy soils and abundant pollinators, are linked to mental capital indirectly, by maintaining the visible and audible nature people actually encounter. This should include sensory and accessibility research for visually impaired people, neurodivergent people, older adults, children, people with anxiety, and communities with limited mobility. Forgotten ecosystems may matter disproportionately because, for some communities (particularly where formal parks are scarce) they are among the most accessible everyday nature.

R6.12 Stronger investment in maintenance of nature infrastructure

Forgotten ecosystems often lose their value in two ways: neglect making them feel unsafe, or over-tidying that diminishes their ecological function and regulating services. Future studies should compare maintenance regimes such as pollinator-sensitive mowing, rotational scrub management, pond restoration, deadwood retention, soil protection, interpretation of ecological services in brownfields, and community stewardship. These should be evaluated for their ecological and human health outcomes relating to biodiversity, habitat condition, perceived safety, use, social trust, and wellbeing.

R6.13 Capture mental capital co-benefits in biodiversity goals

Research should examine how existing policy tools can capture mental capital co-benefits or considerations without weakening biodiversity goals. Biodiversity Net Gain and Local Nature Recovery Strategies can help identify and maintain forgotten ecosystems, but they do not automatically capture public access, sensory experience, interpretation, stewardship, or everyday wellbeing. Research could test whether a forgotten ecosystem screen within planning and nature recovery can improve decisions about retention, enhancement, maintenance, and access. The goal is to move towards identifying which overlooked habitats can be protected, how they should be managed, who benefits from them, and how they contribute to mental capital and societal resilience.



11. Communicating the environment - national security nexus

This section considers how the environment-security nexus can be effectively communicated to the public in a way that clearly explains the risks, sets out the need for change, and generates a political mandate for action.

This is challenging because environmental and national security issues are characterised by complexity, interdependence, uncertainty, and long time horizons, making them difficult to communicate and act upon. Many associated risks, particularly those linked to environmental degradation and ecosystem change, can appear abstract, indirect, or remote from everyday experience. At the same time, policy attention is shaped not only by evidence, but also by political priorities, institutional cultures, prevailing narratives, and the availability of trusted networks and champions. In this context, communication plays a critical role in shaping understanding, facilitating coordination across sectors and institutions, and supporting action under conditions of uncertainty. Effective framing can help make complex risks more tangible, bridge disciplinary and organisational divides, and influence how problems, opportunities, and policy responses are understood.

Section 10.1 considers evidence on public attitudes towards environment and security risks and introduces the concept of "pluralistic ignorance", which can lead to decision paralysis. Next, Section 10.2 summarises evidence on some key communication challenges, and finally Section 10.3 recommends how to communicate environment-security issues effectively.

11.1. Public salience and behavioural considerations

Public attitudes towards environmental and security risks

Existing UK research suggests that public concern regarding environmental and climate risks is generally higher when impacts are perceived as immediate, visible, and connected to everyday life.[84] Issues such as flooding, heatwaves, energy prices, food costs, and water security tend to generate greater salience than more abstract or geographically distant concerns, such as biodiversity loss or ecosystem degradation.[85] Public attitudes also appear to differ across environmental domains. While concern about climate change has become increasingly mainstream in the UK,[86] it continues to vary by political affiliation, educational attainment, and geographic region and is shaped by other contextual factors, such as cost of living.[87]

Support for nature protection measures, by contrast, tends to retain broad-based appeal, particularly when framed around limiting harm and disruption to local landscapes, public health, livelihoods, or community resilience.[88]

Pluralistic ignorance and decision paralysis

Even where concern about environmental security risks is relatively widespread, this does not necessarily translate into visible public support for action. One contributing factor may be "pluralistic ignorance", whereby citizens, including some policy actors and decision-makers, underestimate the extent to which others share their concerns or support policy interventions.[89] This can create a self-reinforcing perception that action lacks public legitimacy or political feasibility, even when private concern is high. This can contribute to institutional caution, political inertia, and limited public discussion of long-term environmental-security risks, even though climate and ecosystem risks are already recognised as relevant to UK food security, supply chains, public health, and geopolitical resilience.[90] Communication strategies that make social concern and support for action more visible may therefore help strengthen collective engagement and policy traction.[91] For example, seeing high-profile figures discussing climate change can encourage others to do the same, as can building up confidence and competence through education about climate issues.[90]

11.2. Communication challenges

Psychological distance

Many environmental-security risks are perceived as distant in time, geography or social context from everyday experience.[92] Risks associated with biodiversity loss, ecosystem degradation, or long-term climate impacts can therefore struggle to generate public and political salience, particularly when compared to more immediate concerns.[93] Existing behavioural science research suggests that issues perceived as distant are often viewed as more abstract and less actionable.[94] Even when environmental-security risks are experienced at the individual or community level, evaluations of personal vulnerability and propensity for climate change action may remain unaffected.[95] Communication strategies that connect these risks to tangible, visible, and near-term impacts, such as flooding or wildfires, may therefore improve perceived relevance.[96]

Local versus systemic framing of risks

Environmental security risks operate simultaneously at local, national, and global scales.[97] However, communication often struggles to balance these perspectives effectively.[98] Local framing can increase salience and emotional engagement by connecting issues to visible and place-based impacts,[99] while systemic framing is necessary for understanding interconnected and cascading risks across sectors and geographies.[100] Overemphasis on either perspective can create challenges: highly local framing alone may not automatically yield higher engagement,[101] while overly systemic framing can appear abstract and difficult to relate to.[102] Effective communication may therefore require layered and bridging approaches that connect concrete local examples to broader systemic dynamics.[103] For example, the online environment might usefully facilitate algorithmically-targeted communications.

Communicating uncertainty

Environmental security issues are characterised by long time horizons,[104] an uneven or incomplete evidence base,[105] and complex interactions between environmental, political, social, and economic systems.[106] Policymakers are therefore often required to make decisions despite persistent uncertainty.[107] However, uncertainty can be difficult to communicate effectively,[108] particularly where it is interpreted as a lack of knowledge[109] or grounds for disengagement or inaction.[110] Communication approaches should distinguish between uncertainty regarding precise outcomes (e.g., "Will a severe drought in the UK lead to violent protests over water rationing by 2035?") and broader confidence regarding the existence of underlying risks and trends (e.g., "Does climate change act as a risk multiplier in the UK by worsening water scarcity and livelihood vulnerabilities?")[111] Framing uncertainty in positive over negative terms,[112] an emphasis on resilience and action-orientation,[113] the adoption of more accessible terminology (e.g., referring to 'a range' of possible outcomes rather than 'uncertainty')[114] and clear attribution messaging[115] may help support decision-making in the environmental-security domain without overstating confidence or creating false precision.

Communicating cascading and interconnected risks

Environmental security risks rarely occur in isolation. Climate change, biodiversity loss, infrastructure disruption, migration, food insecurity, economic instability, and political tensions can interact in complex and reinforcing ways, producing compound and cascading risks that are more difficult to anticipate, communicate, and manage.[116] Communicating these cascading and interconnected risks presents a major challenge, as highly complex systems can quickly become difficult to follow or operationalise. Several interviewees highlighted the importance of causal pathways, diagrams, and visual frameworks for helping policymakers and wider audiences understand how risks propagate across systems. This is consistent with systems-mapping approaches that use causal pathways and visual tools to illustrate relationships, identify transmission pathways, and support discussion of potential intervention points.[117] Effective communication may therefore require simplifying structure and relationships without oversimplifying the underlying dynamics, feedbacks or uncertainties involved.

Balancing urgency with actionable pathways

Communication focused primarily on catastrophic risks or systemic collapse can contribute to disengagement, fatalism, or defensive avoidance, particularly where solutions remain unclear, distant or politically contested.[118] In interviews, UK policymakers noted that institutions are often reluctant to communicate risks publicly in the absence of identifiable responses or intervention pathways, but this 'delayed disclosure' problem reduces public awareness and thus the mandate for action. Effective communication may therefore require balancing urgency with actionable pathways for mitigation, adaptation, and resilience-building. Evidence from climate communication research suggests that risk-based messages are more likely to support constructive engagement when paired with efficacy, agency, and feasible response options.[119] This includes identifying practical interventions, highlighting costs and rewards (short- and long-term), examples of successful action, and framing environmental security challenges not only as risks to be managed, but also as opportunities to strengthen long-term resilience and preparedness. There is a particular gap around communicating the economic benefits of climate action.

11.3. Communication recommendations

Connect environmental security risks to tangible and immediate impacts, including the costs of action and inaction

Where possible, frame risks in relation to issues that are already salient to policymakers and the public, such as food security, energy reliability, flooding, public health, economic stability, and critical infrastructure. Tangible "hooks" (e.g. "there are only 72 hours of food stocks in the UK") can help to start a wider conversation about the need for strategic long-term action.

Use local examples to illustrate wider systemic risk

Place-based examples can increase relevance and engagement, but should be linked to broader environmental, economic, and security dynamics to avoid obscuring underlying drivers and interdependencies.

Communicate uncertainty through a risk management and resilience lens

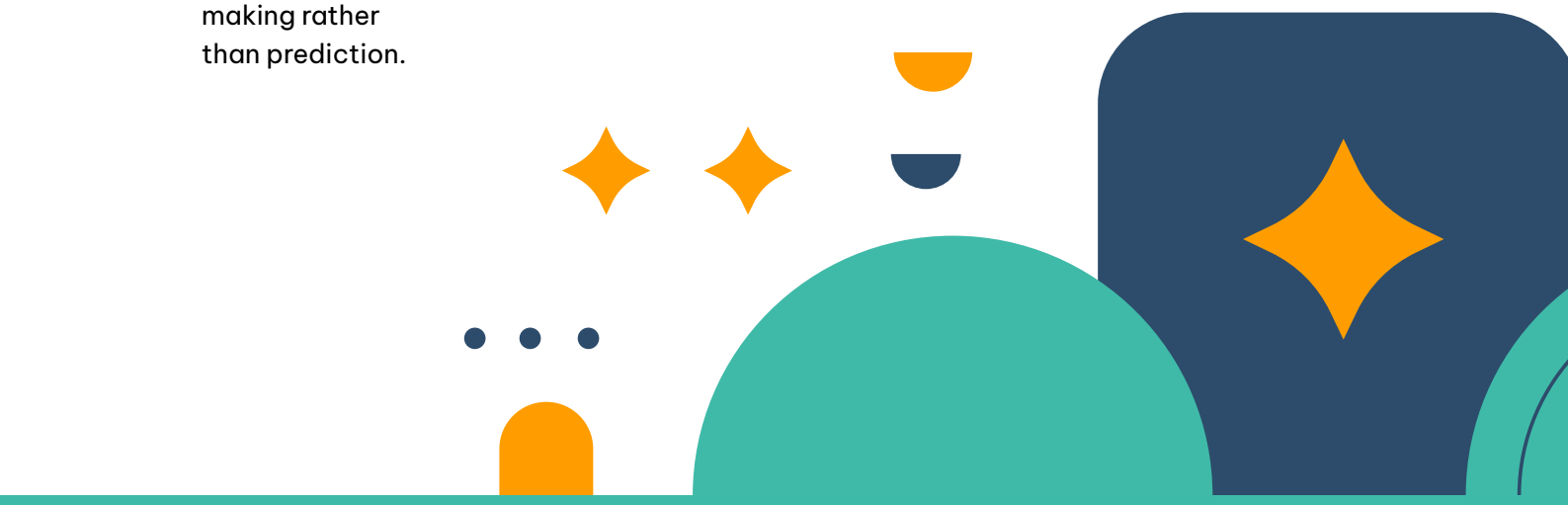
Distinguish between uncertainty about precise outcomes and confidence in the existence of underlying risks and trends. Focus on preparedness, adaptation, and robust decision-making rather than prediction.

Make social concern and support for action more visible

Evidence suggests that public support for environmental and climate action is often underestimated. Communicating existing levels of concern and support may help counter perceptions that action lacks political legitimacy or public backing.

Balance urgency with actionable pathways

Messages land better if backed by funding and action; this shows that policymakers take the issue seriously and inspires hope rather than fatalism, apathy or despair. Communications should clearly convey the seriousness of environmental security risks while identifying practical opportunities for mitigation, adaptation, resilience-building, and preparedness.



Use systems-based communication tools where appropriate

Conceptual frameworks, causal pathways, scenarios, and visualisations can help explain interconnected and cascading risks while supporting more integrated decision-making.

Tailor communication to audience priorities and decision contexts

Different audiences may respond to different framings. Linking environmental risks to operational objectives, resource security, resilience, or preparedness may increase relevance in some policy settings.

Support cross-sector and cross-government understanding

Communication products should help build shared understanding across environmental, security, economic, and development communities, reducing fragmentation and supporting coordinated action. Cross-departmental working groups are proving effective for raising awareness and breaking down silos, but policymakers noted that a directory could be useful to help identify relevant staff in other departments.

12. Behavioural and institutional levers for change

There is a general research gap around moving from understanding of risk to designing interventions to tackle the risks. This needs to cover both specific, narrow risks and solutions, and strategic interventions at a higher level.

This section builds on the pathway analysis to identify intervention opportunities that may help reduce vulnerability, strengthen resilience, and improve preparedness (Section 11.1). It draws on the causal pathway diagrams linking environmental change to national security risks in the six summary reports of key findings for each theme (see example in Figure 2). While these pathways differ in their specific mechanisms and outcomes, they also reveal common points at which behaviour, decision-making processes, institutional arrangements, and governance structures influence how risks emerge, propagate or are managed.

Particular attention is given to behavioural and institutional leverage points that recur across multiple pathways, as these may offer opportunities for action with benefits extending across several environmental-security challenges (Section 11.2). Key factors that can influence successful implementation using case studies of past interventions are highlighted (Section 11.3) and future directions for research and policy are suggested (Section 11.4).

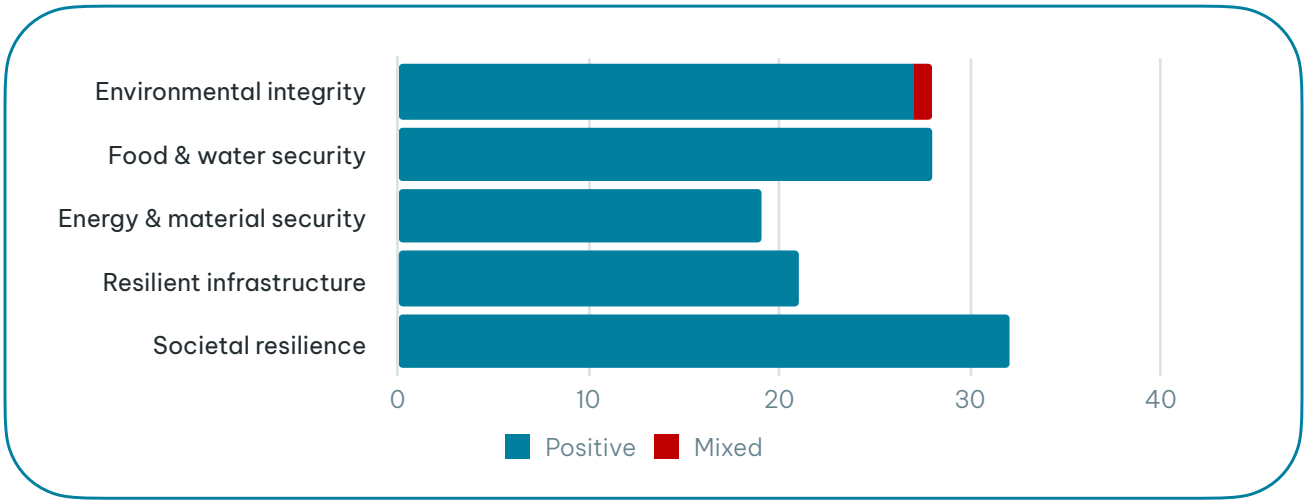
12.1. Analysis of potential intervention opportunities

A list of 54 potential interventions across all six themes was compiled from the policy recommendations in the evidence synthesis reports. These interventions were mainly focused on addressing the specific policy questions for each theme that were suggested by policy partners.

These were then classified to show how each intervention could help to deliver five key requirements for environmental security: environmental integrity (by securing critical natural infrastructure for climate and nature), food and water security, energy and material security, resilient infrastructure, and societal resilience (Figure 5, full table in Appendix 1).

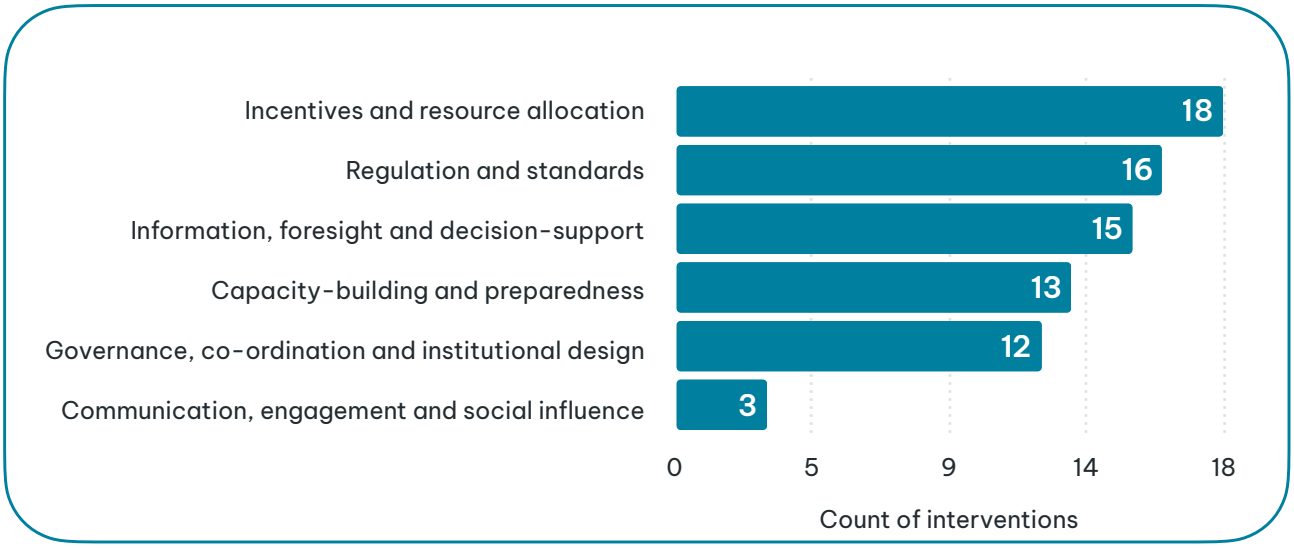
Most interventions had multiple benefits (see section on Cross-cutting interventions below). Only one trade-off emerged: securing critical minerals to boost energy security has potential negative impacts on environmental integrity, depending on how this is achieved (e.g. recycling vs seabed mining). This is the single 'mixed' impact in Figure 5.

Figure 5. Number of potential interventions addressing each challenge



Although these interventions differ in their specific objectives and contexts, many can be grouped into six types of behavioural and institutional intervention, which operate by influencing how individuals, organisations, and governments make decisions, coordinate actions, and respond to emerging risks. These include regulation, incentives, information, governance, capacity building and communication, with several falling under more than one category. Of the 54 interventions, the most common type was provision of incentives and resources, closely followed by regulation, and then information (Figure 6). Strikingly, only three of the identified interventions involved communication and engagement.

Figure 6. Types of interventions identified from our pathways



Regulation and standards

Regulation and formal standards work by altering the rules, constraints, and obligations that shape behaviour, creating clearer expectations and increasing accountability. In many cases, regulation serves as a mechanism for overcoming collective-action problems by ensuring that desired behaviours do not depend solely on voluntary participation.

Examples: statutory targets, due diligence requirements, planning reform, mandatory flood-management measures, energy and water efficiency standards, and proposed ecocide legislation.

Most relevant themes: Critical natural infrastructure (e.g. protecting forests and oceans), Food and energy demand (e.g. efficiency standards), and Weaponisation of nature (e.g. global agreements to protect nature during conflict).

Incentives and resource allocation

Several pathways highlight the importance of aligning incentives with environmental security objectives. These interventions influence behaviour by altering the costs and benefits associated with different actions, encouraging individuals and organisations to make choices that contribute to resilience, preparedness, and sustainability. Incentive-based approaches may be particularly important where desired behaviours generate public benefits but impose private costs.

Examples: subsidy reform, carbon pricing, agri-environment schemes (government payments for farming more sustainably), compensation schemes, and targeted investment mechanisms.

Most relevant themes: Shipping (e.g. investing in resilient ports), Critical natural infrastructure (e.g. rewarding sustainable agriculture to support pollinators), Energy and food demand (e.g. incentivising sustainable food choices).

Information, foresight, and decision support

Many intervention opportunities focus on improving decision-making under conditions of uncertainty. These interventions aim to improve the quality, availability, and use of information, helping actors anticipate risks, identify emerging threats, and respond proactively rather than reactively. Their recurring presence across pathways suggests that information deficits and limited foresight represent common barriers to effective environmental-security governance.

Examples: early warning systems, stress-testing exercises, environmental observatories, monitoring frameworks, dashboards, and shared evidence platforms.

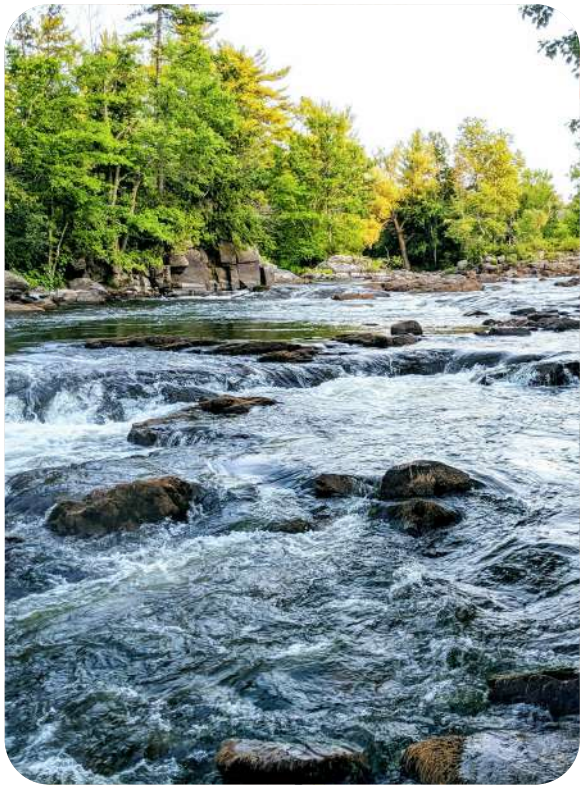
Most relevant themes: Shipping and Societal resilience (mapping dependencies, providing early-warning systems and developing decision-making frameworks).

Governance, coordination and institutional design

A recurring theme across multiple pathways is the challenge of fragmented responsibilities and siloed decision-making. These interventions seek to improve coordination between actors, clarify responsibilities, and facilitate collective action across organisational boundaries. Their prevalence across pathways suggests that institutional fragmentation may represent a significant constraint on effective responses to environmental-security challenges.

Examples: cross-government units, statutory forums, integrated planning mechanisms, and strengthened governance arrangements.

Most relevant themes: Environment-driven mobilities (stronger agency for local communities), Societal resilience (cross-government co-ordination to integrate societal resilience into policy).



Capacity building and preparedness

Several interventions focus on strengthening the ability of individuals, organisations, and institutions to anticipate, prepare for, and respond to environmental-security risks. These interventions aim to ensure that actors possess the resources, skills, and organisational capabilities required to act effectively when risks materialise. Unlike interventions focused on changing behaviour directly, these approaches seek to expand the ability to act.

Examples: resilience frameworks, adaptation planning, preparedness exercises, and long-term capacity-building initiatives.

Most relevant themes: Food and energy demand (grid modernisation, energy storage, peak demand management); Shipping (improving resilience and preparedness in ports);

Communication, engagement, and social influence

Relatively few interventions identified across the pathways focus directly on communication, engagement or social influence. These interventions seek to influence behaviour by increasing salience, shaping perceptions, and making support for action more visible. Their comparatively limited representation within the pathways may suggest that environmental security thinking remains more strongly focused on governance, regulation, and monitoring than on the social and behavioural drivers of change.

Examples: public education initiatives, awareness campaigns, and efforts to increase understanding of environmental-security risks.

Most relevant themes: Food and energy demand (encouraging a shift to a circular economy and sustainable plant-based diets); Environment-driven mobilities (education on biosecurity risks).

Cross-cutting interventions

Most (40 out of 54) interventions addressed more than one environmental security challenge, with seven addressing four challenges and two addressing all five challenges (Figure 7). This does not imply that interventions addressing only one challenge are less important. However, those that address multiple challenges could potentially be more effective, and could also help to break down policy silos and build a bigger momentum for change.

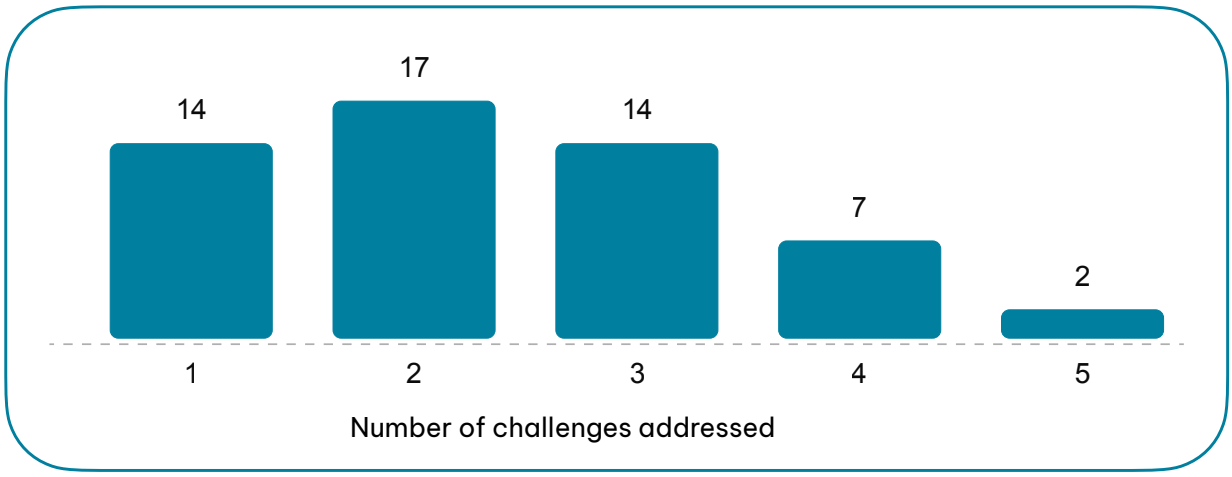


Figure 7. Number of challenges addressed for the interventions identified

The two potential interventions that could address all five challenges both involved more holistic and long-term policy and decision-making:

- Governance: legally binding, cross-departmental policy frameworks, mandating statutory targets to survive election cycles.
- Governance: transition to an integrative system where flood and drought management decisions explicitly account for food security and carbon emissions.

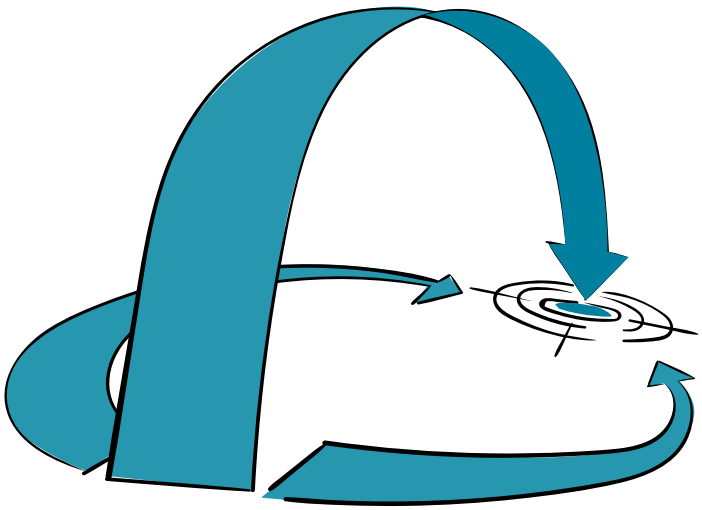
Of the seven interventions that addressed four challenges, two involved demand management (for promoting circular economies and water efficiency), three involved integrated land-use policies and nature-based solutions, and two involved shipping resilience, which is important for food and material security as well as resilient infrastructure.

Current governance barriers to implementation

Independent reviews of UK climate adaptation and resilience suggest several recurring weaknesses.

1. **Responsibilities are spread across departments, regulators, local authorities, infrastructure operators, and private actors**. This makes implementation difficult where risks cut across food, energy, nature, ports, health, housing, and national security. Without clear ownership, cross-system risks can become widely recognised but weakly delivered.

2. **The current system is better suited for response rather than prevention**. Many of the proposed interventions require investment before disruption occurs. These measures often produce benefits through avoided losses, which can be harder to prioritise within short-term political and spending cycles.



3. **There is a gap between national strategy and delivery capacity**. The central government can set priorities, but many interventions depend on localised implementation by authorities, communities, and households. A largely voluntary or market-led approach may not be enough, because many resilience measures require private actors to pay upfront for benefits that are shared across society.

4. **Resilience remains difficult to measure**. Unlike emissions reduction, many environmental security interventions lack clear targets, thresholds, or metrics for success. This makes it easier to produce strategies without demonstrating whether risk is actually being reduced.

The implication is that institutional change should focus less on creating more standalone strategies and more on strengthening delivery. Overall, the UK Government is well placed to implement some interventions where legal authority and national standards are sufficient. It is less suited where implementation depends on long-term prevention, cross-departmental coordination, local delivery, and private-sector action.

12.2. How can behavioural science improve intervention effectiveness?

The intervention opportunities identified across the pathways are dominated by funding, regulation, governance, monitoring, and planning. While these are likely to be necessary components of an effective environmental security strategy, relatively limited attention is given to the behavioural and social processes that shape whether such interventions are accepted, implemented, and sustained over time. Behavioural science therefore offers an opportunity to complement existing approaches by identifying interventions that address barriers related to decision-making, coordination, public acceptance, communication, and behaviour change.

Public acceptance and political feasibility

Many proposed interventions require changes in behaviour, consumption patterns, land use, infrastructure development, or resource allocation. Behavioural science can help identify factors that shape public acceptance of these measures, including perceptions of fairness, trust, risk, and legitimacy.[120] Potential interventions could include framing interventions that emphasise co-benefits (e.g. linking adaptation measures to health, economic resilience, or food security), participatory decision-making processes that increase legitimacy and public buy-in, public acceptability testing of proposed policies before implementation, and social norm campaigns that make support for adaptation or resilience-building more visible.[121]

Collective action and coordination

Several risk pathways identify challenges related to fragmented responsibilities, institutional silos, and coordination failures. Behavioural science can contribute by examining how cooperation emerges between actors and how collective-action problems can be overcome.[122] Potential interventions could include cross-sector communities of practice that facilitate knowledge exchange, joint targets or shared performance indicators across departments and organisations, commitment mechanisms that encourage actors to coordinate around common goals, and structured stakeholder dialogues designed to reduce siloed decision-making and improve collaboration.[123]

Communication and salience

Many environmental security risks are characterised by long causal chains, uncertainty, and limited visibility. Behavioural science can contribute to the design of communication strategies that increase salience, reduce psychological distance, and support informed decision-making.[124] Potential interventions could include the use of local and place-based case studies to make risks more tangible, visual pathway maps that illustrate how environmental changes translate into security outcomes, public-facing dashboards that make risks and progress visible, and messaging that emphasises preparedness, resilience, and practical responses rather than focusing exclusively on risks or catastrophe.[125] For example, "Solutions journalism" — rigorous reporting of responses to societal problems that includes evidence of effectiveness, applicability to other locations, and any limitations — has been linked to greater support for collective action.[126]

Implementation and behavioural compliance

The effectiveness of many interventions ultimately depends on how individuals, organisations, and institutions respond to them in practice. Behavioural science can help identify barriers to implementation, understand unintended consequences, and design supportive environments that facilitate uptake.[127] Potential interventions could include simplifying funding application, reporting, or compliance procedures, introducing default options that support desired behaviours, developing feedback mechanisms that allow organisations to monitor progress, and creating recognition schemes or benchmarking exercises that reinforce positive behaviour and encourage continuous improvement.[128]

Demand-side behavioural change

Several risk mitigation pathways, particularly those linked to food, energy, and resource use, ultimately depend on changes in patterns of consumption and behaviour. Behavioural science can contribute by identifying interventions that support more sustainable choices while maintaining public support and political feasibility.[129] Potential interventions could include social norm interventions around food consumption and resource use, choice architecture approaches that make sustainable options easier or more attractive, personalised feedback on household energy and water consumption, and community-based programmes focused on preparedness, resilience, and resource efficiency.[130]

Decision-making under uncertainty

A recurring theme across multiple pathways is the need to make decisions in the face of uncertainty, long time horizons, and incomplete information. Behavioural science can contribute by helping decision-makers anticipate and mitigate common biases associated with uncertainty, such as present bias, status quo bias, and loss aversion.[131] Potential interventions could include structured decision-making frameworks, pre-mortem exercises, scenario planning workshops, horizon-scanning exercises, and decision-support tools designed to encourage consideration of long-term risks and alternative futures.[132]

12.3.Learning from case studies: what works?

This section compiles some findings on success factors for environment-security interventions, drawn from real-life case studies.

Political feasibility: Learning from energy subsidy reform

The problem: Subsidies for fossil fuel production and use are driving environmental and climate damage and increasing the risk of passing tipping points. Conversely, redirecting these subsidies towards a transition to clean energy and nature recovery would have multiple benefits. However, removing subsidies – especially those directed at end-users – is politically very challenging and can generate a backlash against environmental policy.

Good practice solutions: A review by the World Bank[133] found that subsidy reform only works well if a comprehensive **political economy analysis** is carried out first, to establish how different stakeholders view the reform, how they can exert influence, and what compromises can prevent reforms from being blocked. A concerted effort is needed to reach the full range of stakeholders (public, business, investors, civil society), including surveys, focus groups, in-depth interviews and media analysis.

This should then be used to design a **public communication strategy**, ideally championed at the highest level of government (e.g. No. 10, Cabinet Office etc) and with consistent messaging across all departments to build public trust, but with messages tailored to different stakeholder groups as necessary. These processes should be informed by international experts from multiple disciplines working closely with local stakeholders to understand the local context. Consistent funding is needed to enable agile responses to challenges as they arise, e.g. hostile media reports.

Wider relevance: These findings could have relevance for any intervention that could be politically or culturally unpopular, or challenges vested interests, including demand-management approaches that aim to shift consumer food, travel and energy choices towards more sustainable options.

Public acceptance: Citizens' assemblies

The problem: Some interventions to improve environmental security may be politically unpopular, either because they entail increased costs, inconvenience or restricted choices, or due to misinformation propagated for political reasons or by vested interests.

The solution: Citizens' Assemblies bring together randomly selected but representative members of the public to hear from experts and then engage in constructive discussions on sensitive and complex environmental issues. They have been successfully used at national level to discuss how to meet climate targets, how to halt

biodiversity loss and how to prioritise climate change adaptation actions,[134] with a growing number of local assemblies as well.[135] Many citizens are more willing to accept costs or inconvenience once they understand the need for change and have had the opportunity to express their concerns and discuss them with other people who hold a range of different views. The outcome of a Citizens' Assembly can help to inform government policy and can give policymakers the confidence that they are acting in accordance with public wishes.

Wider relevance: As the need for stronger and faster action to halt environmental degradation becomes ever more urgent, further Citizens' Assemblies (perhaps aligned with the recent National Emergency Briefing and People's Emergency Briefing[136]) could help to arrive at a consensus on the need to urgent action and could galvanise policymakers to act more swiftly and confidently.

Collective action: Place-based alliances

The problem: Environment-security challenges are complex and require many different groups to work together, including households, national and local governments, regulators, businesses, investors and researchers. However, often people find themselves working in isolated groups or silos, which can delay progress and lead to lack of trust and coordination between different sectors such as climate, energy, nature, health, transport, housing and economy.

Good practice solutions: Place-based alliances such as the Yorkshire and Humberside Climate Commission (YHCC) bring together local authorities, national government, businesses, researchers and civil society to agree common goals, targets and metrics, share knowledge and evidence, bid for funding, and provide mutual support and encouragement.[137] For example, in its first three years the YHCC developed a joint climate action plan, incorporated eight climate and nature principles into the regional planning strategy, and supported all 15 local authorities to develop climate adaptation plans. They now support a thriving network of local groups driving forward initiatives on nature, climate, circular economy and just transition. At a smaller scale, community energy groups can use their collective bargaining and organising power to set up local renewable energy schemes that save money, cut emissions and increase energy independence.[138]

Wider relevance: Strong communities of practice such as the YHCC can address multiple aspects of the environment-security challenge, with their goals and activities spanning nature, energy, food, and societal resilience. However, they require sustained funding and effort – some similar groups that were set up with one-off funding agreements have not survived.

Coordination: Green shipping corridors

The problem: Transitioning to low-carbon energy in shipping is challenging because of a chicken-and-egg situation: it is not worth building clean fuel supply infrastructure until ships need to use it, but it is not economic to build low-carbon ships until the fuel supply and refuelling infrastructure exists.

The solution: At COP26, the Clydebank Declaration was set up to develop zero-emission shipping routes. Governments at each end of a proposed green shipping corridor commit to align regulations and investment towards maritime decarbonisation. This creates cross-sector communities of practice, bringing together ports, shipping operators, fuel suppliers, and governments to coordinate implementation. It also sets shared expectations among states and industry actors on the future transition to green fuel and infrastructure, helping to shift the social norm. The 2025 progress report records 84 active initiatives, of which four are about to become operational.

Wider relevance: This model of small groups of willing partners working together to stimulate investment and shift expectations could have wider relevance for other challenges where it is hard to reach global consensus.

Demand-side behaviour change: Energy saving programmes

The problem: It can be challenging to alter long-established patterns and habits of energy use.

The solution: A range of options have been successful. **1. Personalised feedback** on energy or water consumption via use of smart meters; the success of these schemes depends on effective engagement before installation, clear and reliable technology, setting realistic expectations of energy savings, and offering meter installation as an optional choice rather than a mandatory roll-out.[139] **2. Shifting social norms**, such as the 'cool biz' office wear standards in Japan which encourage employees to abandon jackets and ties, and wear shorts.[140] **3. 'Choice architecture'** approaches that make sustainable options more attractive or convenient, such as provision of safe cycling routes in London.

Wider relevance: Shifting to more sustainable behaviour patterns requires approaches informed by behavioural science which encourage people to make beneficial changes voluntarily.

Decision-making under uncertainty: The Thames Barrier

The problem: As sea-level rises, the risk of waves overtopping the existing Thames Barrier increases, but the risks are highly uncertain as they depend on future emissions, complex natural systems and potential tipping points. The high costs of new defences, severe consequences if the barrier fails, and

long construction times to build new defences combine to give a high potential for maladaptation.

The solution: The Thames Estuary 2100 project has adopted a structured decision-making approach to deal with deep uncertainty.[141] This involves understanding relevant thresholds (in this case, a 5m sea-level rise would breach the existing barrier), modelling a range of extreme scenarios to test sensitivity to unknown factors, identifying feasible options to deal with each scenario, assessing trade-offs and dependencies with other factors such as ongoing environmental impacts and urban development, carrying out cost-benefit analysis for each option (including wider environmental and other impacts) and finally recommending the preferred option under the most likely rate of change, and defining a monitoring system to assess if a different option will be needed in the future.

Wider relevance: Many environment-security impacts are highly uncertain, so structured decision-making to identify no-regrets options and set out alternative courses of action that can be adapted to changing circumstances offers a useful way forward.

Breaking down silos: Jordan's Climate Security Intelligence Team (CSIT)

The problem: Different parts of national governments often underappreciate environment to national security risk pathways and the myriad ways climate and environment change can impact areas in their purview and relate to the responsibilities and expertise found in other departments. This means opportunities for informed decision-making are missed.

The solution: Building an all-source, multi-agency fusion centre capability at the heart of government to provide analysis. Despite only becoming operational in early 2026 in the National Centre for Security and Crisis Management (NCSCM), the Climate Security Intelligence Team (CSIT) capability brought together specialists from many departments, municipalities and agencies, including those with national security responsibilities. The fusion centre draws on internal government information as well as public and scientific data to provide analysis on specific risks and opportunities at different scales. In Jordan this has enabled decisions to be taken with impact. These have included: forward-deployment of medical, veterinary and testing facilities into areas at heightened risk of climate-driven pests and diseases; military units collecting climate and environment data from difficult to access areas; flash flood-related alert and evacuation plans being refined; procurement of urban infrastructure to higher temperature standards; and shifts to the dates of the official tourist seasons to better keep tourists and workers safe.

Wider relevance: The approach adopted in Jordan, which draws on and connects existing policy specialists and mandates, is replicable elsewhere. More of these capabilities would ensure more data and analysis which could be shared enhancing understandings at regional levels.

12.4.Future directions and research gaps

The potential interventions identified by this research sprint are a useful starting point for further analysis. However, the next steps should bring a much wider range of academics and stakeholders together to broaden the discussions, expand the list of interventions, delve into potential synergies and trade-offs, and ground the interventions in the reality of lived experience. Some specific future research priorities are listed below.

Public acceptance and political feasibility

- *What factors most strongly influence public and political acceptance of environmental-security interventions?*
- *Which framings are most effective at building support for interventions that impose short-term costs in pursuit of long-term resilience?*
- *How do perceptions of fairness, legitimacy, and trust shape support for adaptation, demand-management, and resilience policies?*
- *What is the influence of misinformation from the media and/or vested interests on public policy to address environmental security, and how can this be addressed?*

Collective action and coordination

- *What institutional arrangements are most effective at overcoming coordination failures across sectors and government departments?*
- *How can behavioural approaches support cooperation among actors with competing incentives, priorities, and time horizons?*
- *What role do social norms, trust, and reciprocity play in facilitating collective responses to environmental-security challenges?*

Communication and salience

How can environmental-security risks be communicated in ways that reduce psychological distance while preserving systems-level understanding? For example, how can links from environmental degradation to salient issues such as food and fuel prices be made clearer?

How can policymakers communicate interconnected and cascading risks without overwhelming or losing the interest of audiences?

What communication approaches are most effective at conveying uncertainty without reducing support for action?
'

How can we communicate the risks of unprecedented events such as extreme weather, including those that could happen in the present day?

Implementation and behavioural compliance

What factors determine whether environmental-security interventions are implemented successfully in practice?

Which behavioural barriers most commonly undermine implementation, and how can they be addressed?

How do organisations respond to new regulatory, planning, and resilience requirements?

Decision-making under uncertainty

- *How do policymakers make decisions under conditions of deep uncertainty and across long time horizons?*
- *Which decision-support tools are most effective at reducing biases associated with uncertainty?*
- *How can we make robust decisions without waiting for precise evidence, using different sources of information each with their own uncertainties?*
- *How can foresight, scenario planning, and adaptive management approaches be integrated into environmental-security governance? Cross-cutting behavioural dimensions of environmental security*
- *Which behavioural and institutional leverage points recur most consistently across environmental security risk pathways?*
- *How can behavioural science be integrated more systematically into environmental-security policy design and evaluation?*
- *Are there intervention types that generate benefits across multiple pathways simultaneously?*
- *How does inequality and identity politics (blaming marginalised groups) act as a threat multiplier for security and conflict issues?*

Positive tipping points, sensitive intervention points and derailment risks

"Positive tipping points" are where strong amplifying feedback supports self-propelling nature-positive change,[142] and "sensitive intervention points" are where small interventions can drive outsized impacts and transformational change.[143]

An example of a sensitive intervention point might be to require an environmental-security risk test for all major government spending decisions such as Spending Review bids, departmental budget allocations and infrastructure investment business cases. This would force government departments to collect the necessary data to show that there will be no impact on environmental security, and enable the Treasury to start rewarding environmental protection and costing environmental damage in everyday spending decisions. Better data collection would enable more informed decision-making throughout government – at present, for example, the government does not know the economic impact of extreme weather events.

Other examples could include including sustainable drainage systems in all new developments in England (by implementing Schedule 3 of the 2010 Flood and Water Management Act) and using public procurement to shift to more sustainable and healthy diets in schools, hospitals and other public sector settings. All three examples are relatively small changes that could have large impacts by shifting norms to make the sustainable option the default.

Conversely, researchers have also identified negative feedback loops known as derailment risks, where the increasing impacts and costs of climate and environmental breakdown divert funding and attention away from the urgent task of reducing damage at source.[144] Therefore intervention points to break out of these negative cycles are also required.

- Build on existing studies to identify further opportunities for positive tipping points and sensitive intervention points, and work with government to enable these to be deployed.

- What interventions and decision-making tools can be used to break out of negative feedback loops caused by derailment risks?

13. Conclusions and next steps

This project brought together researchers and policymakers in a six-month research sprint to assess the current UK Government position on the links between environment and national security, address key policy questions and develop an agenda for future research.

A series of rapid evidence synthesis reports demonstrate the urgent need to protect critical natural systems and strengthen societal resilience, to avoid triggering catastrophic environmental, social and economic tipping points. However, more research is needed to improve understanding of impacts and their timing, set up monitoring systems and early warning indicators, and design effective interventions. Behavioural science will be also crucial for delivering the changes needed at pace with public support – including countering misinformation from media and vested interests. This report therefore provides a forward-looking research agenda including almost 200 research questions across seven areas (the six research themes plus cross-cutting opportunities in behavioural science).

Analysis of the current policy position found that while the UK Government has been a strong global leader on tackling climate change and is starting to develop capacity on nature security, there are warning signs that climate security and nature protection are being de-prioritised. This is due partly to external political and media pressure (largely attributed to misinformation and vested interests) and partly to a focus on short-term issues such as the Iran and Ukraine wars and the cost-of-living crisis.

An integrated and co-ordinated approach across government is urgently required, supported by a common understanding of how environmental degradation threatens food, water and energy security, social prosperity, geopolitical stability and national security. Taking a systems view will help to identify interventions with multiple benefits across the different dimensions of security, while avoiding conflicts between goals. For example, accelerating the shift to a circular economy can reduce waste of food, water, energy and materials, reducing the need to extract raw materials from sensitive ecosystems (such as mining the seabed for critical minerals). A cross-government approach can also show that tackling environment-security issues will help to address other immediate problems such as high food and energy prices and the economic, health and social cost of climate and nature degradation.

This Agile Initiative project has delivered a strong foundation for further work, but next steps should broaden out the discussion to include a wide range of other academics, policymakers, practitioners, businesses and third sector organisations. A concerted effort will be needed to integrate environmental security into policy and practice, and to design, deliver and monitor effective interventions that can secure a safe, secure and prosperous future for humanity.

Appendix 1: List of potential interventions

The list is ordered according to the six themes: Critical natural infrastructure; Food and energy demand; Shipping supply chains; Environment-driven mobilities; Weaponisation of nature; Societal resilience and mental capital. For more details see the individual reports.

The type of intervention is categorised into **Regulation** and standards; **Incentives** and resource allocation; **Governance**, co-ordination and institutional design; **Capacity-building** and preparedness; **Information**, foresight and decision-support; **Communication**, engagement and social influence. Only the first words (shown in bold here) are used in the table, to save space.

Note that only major benefits are shown. Many of the interventions have additional benefits, e.g. water efficiency will also support energy security by saving energy used to treat and pump water, but this is not shown as it is not considered to be a major tool compared to other energy security options.

Intervention	Type	Environmental integrity	Food & water security	Energy & material security	Resilient infrastructure	Societal resilience
Deforestation legislation: enact secondary legislation mandating corporate due diligence on forest-risk commodities to prevent illegal deforestation	**Regulation**	✓				
Marine protection: enforce scientific catch quotas, ban bottom trawling in Marine Protected Areas, and protect keystone species like whales and krill	**Regulation**	✓	✓			
Pollution control: eliminate untreated sewage discharges and expand microplastic regulations to cover more chemical categories	**Regulation**	✓				✓
Pollinator management: regulate managed honeybee overstocking to protect wild pollinators	**Regulation**	✓	✓			
Planning reform: revise the National Planning Policy Framework (NPPF) to strictly prohibit development on Grade 1 and 2 farmland and tighten rules against building homes or hospitals on floodplains	**Regulation**	✓	✓		✓	✓

Intervention	Type	Environmental integrity	Food & water security	Energy & material security	Resilient infrastructure	Societal resilience
Mandatory SuDS: implement Schedule 3 of the 2010 Flood and Water Management Act to mandate multifunctional Sustainable Drainage Systems (SuDS) in all new developments	**Regulation**	✓			✓	✓
Policy alignment: ensure climate actions do not damage critical natural infrastructure, specifically regulating seabed mining and risky geoengineering like iron fertilisation	**Regulation**	✓				
Nature finance: invest in the Tropical Forests Forever Facility to provide national-level forest protection funding to 74 countries	**Incentives**	✓				
Pollinator management: maintain funding for pollinator habitats such as wildflower strips via ELMs and other agri-environment schemes	**Incentives**	✓	✓			
Pollinator management: use Official Development Assistance to fund global pollinator support	**Incentives**	✓	✓			
Integrated Pest Management (IPM): continue funding IPM via ELMs and other agri-environment schemes to protect beneficial insects and reduce reliance on agrochemicals	**Incentives**	✓	✓			
Nature-based solutions (NbS): Prioritise investment in Natural Flood Management, Paludiculture (wetland farming) and other NbS to adapt to climate change	**Incentives**	✓	✓		✓	✓
Demand management: accelerate circular economy policies	**Regulation Incentives Communication**	✓	✓	✓		✓
Governance: Set up legally binding, cross-departmental policy frameworks with statutory targets to survive election cycles	**Regulation Governance**	✓	✓	✓	✓	✓
Peak energy demand management: mandate high-standard building insulation and implement market designs that reward "time flexibility", such as smart EV charging during off-peak hours	**Regulation Capacity-building**			✓	✓	✓
Demand management: set water efficiency standards for new homes to meet future supply deficits	**Regulation**	✓	✓		✓	✓
Healthy food: shift from voluntary programs to mandatory action such as targeted taxation (e.g. the Soft Drinks Industry Levy)	**Incentives Regulation**		✓			✓

Intervention	Type	Environmental integrity	Food & water security	Energy & material security	Resilient infrastructure	Societal resilience
Governance: transition to an integrative system where flood and drought management decisions explicitly account for food security and carbon emissions	**Information Governance**	✓	✓	✓	✓	✓
Monitoring malnutrition: deploy Early Warning Systems and data-driven decision support systems to monitor malnutrition and trigger automatic emergency responses	**Information Capacity-building**		✓			✓
Consumer demand: encourage a shift from high-emissions red meat and processed foods towards more healthy and sustainable plant rich diets	**Incentives Communication**	✓	✓			✓
Grid modernisation: execute significant grid upgrades to handle a doubling of electricity demand by 2050, prioritising digitisation for resilience against extreme weather	**Incentives Capacity-building**			✓	✓	
Energy storage: prioritise investment in long-duration strategic energy storage	**Incentives Capacity-building**			✓	✓	
Critical minerals: secure critical mineral supply chains for clean technologies	**Incentives Capacity-building**			✓	✓	
Agricultural energy resilience: decouple food production from fossil fuel volatility by integrating renewables and waste-to-energy processes into agricultural activities	**Incentives Capacity-building**	✓	✓	✓		
Subsidies and pricing: reform agricultural subsidies to reward regenerative practices and implement carbon pricing to internalise environmental costs	**Incentives**	✓	✓	✓		
Social safeguards: link social protection payments directly to food inflation and the cost of healthy diets to protect vulnerable households	**Incentives**		✓			✓
Land-use strategies: use an interconnected water-food-energy lens to balance competing demands for food production, habitat restoration, and energy infrastructure	**Governance**	✓	✓	✓	✓	
Supply chain redundancy: incentivise a shift from "just-in-time" to "just-in-case" models by diversifying supply chains, bolstering domestic production, and increasing inventory margins	**Capacity-building**		✓	✓		✓

Intervention	Type	Environmental integrity	Food & water security	Energy & material security	Resilient infrastructure	Societal resilience
Port resilience: support adaptation planning that extends beyond quays to include the hinterland of drainage, power resilience, and road/rail access	**Information Capacity-building**		✓	✓	✓	
Stress-testing supply chains: conduct compound stress tests on UK-critical supply chains, simulating simultaneous disruptions such as Panama Canal droughts, Red Sea conflicts, and storm-driven port closures	**Information**		✓	✓	✓	
Dependency mapping: map specific UK dependence on vulnerable foreign transshipment hubs, e.g. Antwerpen, Rotterdam, Hamburg, and Bremerhaven, which account for 30% of maritime imports.	**Information**		✓	✓	✓	
Shared evidence base for shipping supply chains: create a unified database linking climate hazards, vessel movements, insurance practices, and fuel infrastructure to identify "thresholds" that trigger disruption	**Information**		✓	✓	✓	
Monitor uncertainty in the Arctic: treat arctic routes as a conditional option rather than a guaranteed alternative to the Suez Canal, focusing on Arctic monitoring, hydrography, and science diplomacy	**Information**		✓	✓	✓	✓
Infrastructure redundancy: build state-supported redundancy for critical imports where market-led resilience is insufficient to ensure essential foods remain available during crises	**Incentives Capacity-building**		✓	✓	✓	
Resilient and safe green shipping corridors: make shipping decarbonisation resilient by ensuring clean-fuel hubs (for ammonia or hydrogen) include diversified supply chains and specialised emergency response capabilities for toxic or flammable fuels	**Incentives Capacity-building**	✓		✓	✓	✓
Cargo adaptation: prepare ports for shifting cargo mixes, transitioning from fossil fuel handling to managing clean-energy components and critical minerals	**Incentives Capacity-building**		✓	✓	✓	
Governance leadership: shape international Arctic shipping standards and governance early, before increased traffic creates irreversible facts on the water	**Governance Capacity-building**				✓	✓

Intervention	Type	Environmental integrity	Food & water security	Energy & material security	Resilient infrastructure	Societal resilience
Managed retreat: develop a successor to Floor Re that covers coastal erosion	**Regulation**					✓
Biosecurity: Learn best practices in biosecurity border controls from other island states such as Australia	**Information Regulation**	✓	✓			
Managed retreat: model the impacts of different managed retreat scenarios on inland housing markets, school catchments, NHS demand and council finances	**Information**					✓
Managed retreat: Set up a statutory compensation scheme for managed retreat, including the formalisation of regulator coordination through the establishment of a statutory adaptation forum.	**Incentives Governance**					✓
Managed retreat: Mandate receiving-community plans before retreat-related designations are approved	**Governance**					✓
Coastal protection: create a dedicated statutory forum to oversee climate adaptation for coastal critical national infrastructure	**Governance**				✓	✓
Migration: Home Office to clarify climate vulnerability considerations in immigration decisions under Article 8 and Appendix FM, related to diasporas.	**Governance**					✓
Biosecurity: UK Government to launch a public education programme on national biosecurity risks.	**Communication**	✓				✓
Weaponisation of nature: Integrate environmental restoration into post-conflict reconstruction and peacebuilding processes	**Regulation Governance**	✓	✓			✓
Ecocide: Implement ecocide legislation in the UK	**Regulation**	✓				
Societal resilience: Extend the mandate of Nature Recovery to include mental health resilience infrastructure	**Information Governance**	✓				✓
Societal resilience: Pilot 1) a mental capital / societal resilience guidance framework, 2) a distributional resilience approach, and 3) a Mental Capital and Resilience Net Gain lens as part of the design, appraisal and delivery of place-based programmes including flood adaptation, transport redesign projects and community resilience planning.	**Information Capacity-building Governance**					✓

Intervention	Type	Environmental integrity	Food & water security	Energy & material security	Resilient infrastructure	Societal resilience
Societal resilience: Establish early warning systems for population-level declines in mental capital	**Information**					✓
Societal resilience: Create a longitudinal environmental mental capital observatory	**Information**					✓
Societal resilience: Build an environmental wellbeing risk dashboard and register, possibly in collaboration with the ONS	**Information**	✓				✓
Societal resilience: Develop a national mental capital and environmental security framework	**Information**					✓
Societal resilience: Establish a cross-government Mental Capital and Environment Unit (DHSC, Defra, MoD, DfE, etc.)	**Governance**					✓

Glossary

Abundance is having ample access to a resource, product, or service. It is not a constant state, but relative, and can equate to adequacy as well as plenty.

Climate security encompasses the impacts of climate change on peace, stability, and human well-being. It also relates to the ways shifting climatic conditions amplify, cascade, and compound risks to humans, ecosystems, economy, infrastructure, and societies, including from competition over natural resources, insecure livelihoods, social tensions, and intra- and inter- state violence.

Environment is the dynamic totality of the atmosphere, biota, climate, ecosystems, land, resources, sediments, soil, and water. It is constantly changing through both natural processes (e.g. weather, hydrology, erosion) and activities of humans and other organisms (e.g. habitat construction, physical modification, resource consumption, waste production).

Energy security is the capacity of the UK to reliably meet current and future energy demand, manage domestic and external energy dependencies, and withstand or recover quickly from shocks to energy supply, infrastructure, and markets.

Food security is a condition when all people, at all times, have physical, economic and social access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Fuel poverty is the condition of being unable to meet household energy needs at affordable cost. (Its opposite is **'energy affordability'**.) It is caused by a combination of low income, inefficient housing and energy conversion technologies, and high energy costs. Currently, strategy related to fuel poverty is largely devolved, with each UK nation having introduced its own fuel poverty metric and targets.

Human security is a people-centred approach to security that focuses on the attainment of the social, political, economic, and environmental conditions conducive to survival, livelihood, freedom, and dignity. The approach seeks to identify and address threats and risks to individuals through a concentration on lived experience, personal safety, empowerment, rights, everyday protections, and prevention-orientated responses.

Infrastructure refers to the physical structures, facilities, and systems underpinning a society, including its economy, enterprises, and services. This includes, for example, economic infrastructure, such as roads, bridges, railways, airports, and utilities (such as water supply, waste handling, power supply, telecommunications, and cyber/ digital structures) and social infrastructure (such as community services, schools, hospitals, and housing).

- **Grey infrastructure** is human-built, non-living infrastructure such as buildings, roads, dams and sea walls, typically using materials such as concrete, metal, bricks and timber.

- **Natural infrastructure** can be used in either a narrow or broad sense. The narrow definition refers to the role of natural or managed ecosystems in providing services that could also be

provided by grey infrastructure, such as forests providing flood and erosion protection or wetlands providing water filtration. The broad sense extends this to include other ecosystem services such as healthy soils providing food, flower-rich grasslands supporting pollinators (and hence food), all healthy ecosystems sequestering carbon for climate stability, and nature-rich green space supporting human health and wellbeing.

- **Critical natural infrastructure** refers to the concept of a national network of high-quality natural infrastructure delivering essential services to support human health, economic stability and national security, given the same priority as grey infrastructure, such as roads, schools and hospitals. It also refers to ecosystems in other countries that support critical natural systems such as rainfall generation, climate stabilisation and pollination.

- **Green and blue infrastructure** is a strategic network of multi-functional green and blue spaces and other natural features which is capable of delivering a wide range of environmental, economic, health and wellbeing benefits for people, including urban cooling, runoff management, air quality regulation, noise reduction, green space for recreation, and opportunities to interact with nature. This network can include both natural and hybrid infrastructure, such as street trees, parks, gardens, woodlands, wetlands, green roofs, waterbodies and sustainable drainage systems. It is a subset of natural infrastructure which is important in urban planning but can also apply in rural areas (e.g. sustainable drainage systems treating polluted run-off from roads).

- **Hybrid infrastructure** combines grey and natural infrastructure. Examples include using distinct grey and green elements alongside each other, such as protecting a sea wall with a coastal wetland (thus reducing the height of wall needed and/or its maintenance costs), or creating features with both living and non-living elements, such as rain gardens, green roofs and sustainable drainage systems.

Mental capital: refers to the cognitive, affective, and neurological resources (capacities) that underpin brain health and enable individuals to think, feel, learn, and act effectively across the life course, including core executive functions (cognitive flexibility, impulse control, memory), emotional regulation, emotional intelligence, adaptability, and resilience.

National security refers to the safeguarding of a nation's sovereign territories, citizens, institutions, prosperity, wellbeing, and way of life. This includes protection from threats, such as military attack and other state-based hostilities, including "grey zone" activities, but also action by non-state actors, such as terrorist and criminal groups. The protection of the economy, energy, food, health, and water are also central factors. Usually considered a fundamental duty of government, it is often left without a fixed statutory definition to ensure flexibility in the face of change.

Nature-based solutions (NbS) are actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, with benefits for both people and biodiversity. They involve natural infrastructure in its broadest sense (including green, blue and hybrid infrastructure) but to qualify as NbS they should follow the IUCN Global Standard for NbS, meaning that (amongst other criteria) they should be planned with and for the benefit of local communities and should deliver measurable benefits for biodiversity. Not all interventions badged as NbS meet these criteria.

Policy is the official set of principles, implemented by government at different scales and often supported by associated legislation, to obligate decisions and behaviours in order to achieve sought outcomes. (It can also refer to rules and frameworks adopted by organisations or individuals to set standards and promote consistent behaviours but that is outside of the current project's co-productive scope.)

Policymakers are the individuals involved in the development or revision of policies.

Resilience is the capacity to resist, cope with and/or recover from shocks, or stress. It comprises physical, economic, behavioural, cognitive, and emotional dimensions, with response often involving robustness, recovery, flexibility and/ or transformation. Discussion of resilience requires consideration of (i) of what, (ii) to what, (iii) from whose perspective, (iv) over what time period, and (v) for what purpose, and all responses require adaptation.

Scarcity is a shortage of a resource, product, or service due to a discrepancy between supply and demand.

Sprints are interdisciplinary research projects, with the core research period lasting six to twelve months, with an emphasis on: timely research for a policy window; co-creation with stakeholders and decision makers; and a positive equality impact.

Tipping point is when change in part of a system becomes self-perpetuating beyond some threshold, leading to substantial, widespread, often abrupt and irreversible, impacts.

Weaponisation is the process of adapting, transforming, or arming a concept, object, or substance, to cause harm, deliver an attack, or gain an advantage. Linked to the enhancement of threat-based capabilities of states, groups, or individuals, weaponisation involves intent and is often tailored to threaten or attack a specific target.

Wellbeing is a multidimensional construct encompassing physical and psychological health, life satisfaction, and various individual and social factors, including sense of purpose, self-esteem, community connection, supportive relationships, and positive emotional expression.

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