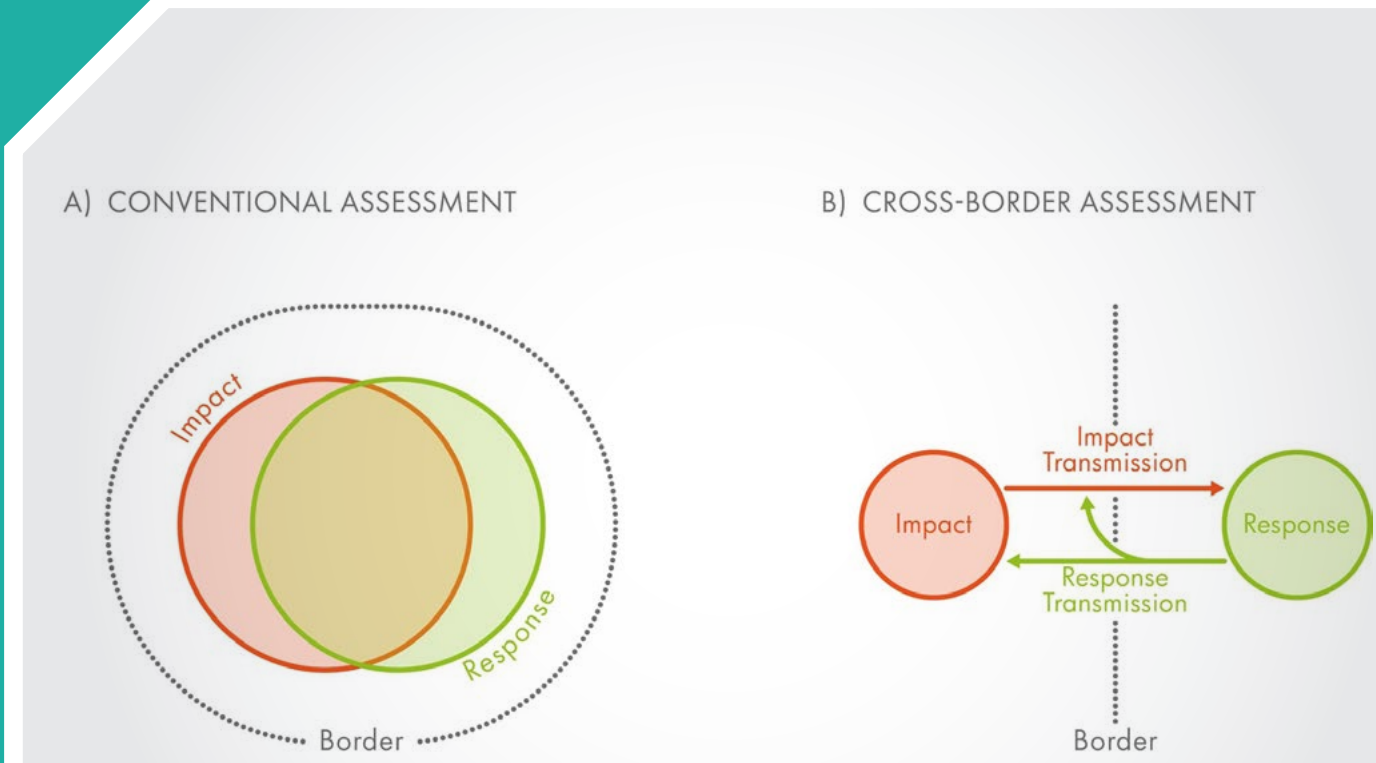
Report No.(449)

epa Research

Transboundary Climate Risks for the Island of Ireland (TCRII)

Authors: Conor Murphy, Kevin Leonard, Rory Moore and Stephen Flood.



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Rialtas na hÉireann
Government of Ireland

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The EPA is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

The work of the EPA can be divided into three main areas:

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Knowledge: Providing high quality, targeted and timely environmental data, information and assessment to inform decision making.

Advocacy: Working with others to advocate for a clean, productive and well protected environment and for sustainable environmental practices.

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- Promote environmental awareness including supporting behaviours for resource efficiency and climate transition;
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- Work with international and national agencies, regional and local authorities, non-governmental organisations, representative bodies and government departments to deliver environmental and radiological protection, research coordination and science-based decision making.

Management and Structure of the EPA

The EPA is managed by a full time Board, consisting of a Director General and five Directors. The work is carried out across five Offices:

1. Office of Environmental Sustainability
2. Office of Environmental Enforcement
3. Office of Evidence and Assessment
4. Office of Radiation Protection and Environmental Monitoring
5. Office of Communications and Corporate Services

The EPA is assisted by advisory committees who meet regularly to discuss issues of concern and provide advice to the Board.

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Identifying pressures

Transboundary climate risks (TCRs) cross national borders. They are associated with climate change impacts that propagate through different pathways to affect other countries and regions and result from climate change adaptations made in one or more countries having repercussions for others. These emerging climate risks are poorly studied, even though they could have significant impacts on a national scale. The Transboundary Climate Risks for the Island of Ireland (TCRII) project undertook a literature review and worked with stakeholders to identify approaches for the assessment of TCRs and synergies that can be leveraged on an all-island basis. The findings informed recommendations for better accounting for these emerging risks, to realise the national climate objective of achieving a climate-resilient economy and society by 2050.

Informing policy

The island of Ireland is one of the most open economies in the world for trade and finance. While this openness has helped to generate significant wealth and improve living standards, it has also created vulnerabilities associated with being small, open and highly globalised. The Transnational Climate Impacts Index ranks Ireland 68th among the countries most vulnerable to TCRs globally. The island's open economy, trade and finance links make it among the most vulnerable to the impacts of climate change on international trade. Coupled with this, the cross-border dimensions of climate change impacts and climate action for the island of Ireland increase the importance of collaboration across jurisdictions.

Developing solutions

Through our analysis, seven risk pathways for understanding and adapting to transboundary climate risks (TCRs) were identified, namely the trade, biophysical, people, geopolitical, psychological, finance and infrastructure pathways. While considering TCRs is relatively new in international policy, Ireland is starting from an advantageous position, with numerous cross-border and international institutions already in place to utilise and learn from. Work with stakeholders highlighted the importance of adopting the above risk pathways as a framework for managing TCRs and the critical need for interdisciplinary research, leveraging existing cross-border institutions and relationships, involving the private sector, international collaboration and developing guidance on evaluating and prioritising TCRs. Planning for and adapting to TCRs is critical for ensuring Ireland's resilience to climate change. Assigning responsibilities for managing TCRs and collaboration and research are essential for building adaptive capacity across all risk pathways.

EPA RESEARCH PROGRAMME 2021–2030

Transboundary Climate Risks for the Island of Ireland (TCRII)

(2021-CE-1043)

EPA Research Report

Prepared for the Environmental Protection Agency

by

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ACKNOWLEDGEMENTS

This report is published as part of the EPA Research Programme 2021–2030. The EPA Research Programme is a Government of Ireland initiative funded by the Department of the Environment, Climate and Communications. It is administered by the Environmental Protection Agency, which has the statutory function of co-ordinating and promoting environmental research.

The authors would like to acknowledge the members of the project steering committee, namely Micheal O'Dwyer, Miriam Kennedy, Jennifer Hobbs, Kevin McCormick and Cathy Burns. Thanks are also extended to Professors Neil Adger and Robert McLeman for their expert input, and to Dr Tara Quinn for providing support and input to project workshops. Finally, we thank all participants of the project workshops who gave so generously their time and expertise, and without whom this project would not have been possible.

DISCLAIMER

This report is based on research carried out/data from April 2022 to March 2023. More recent data may have become available since the research was completed.

The EPA Research Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

EPA RESEARCH PROGRAMME 2021–2030
Published by the Environmental Protection Agency, Ireland

ISBN: 978-1-80009-148-1 February 2024

Price: Free Online version

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Executive Summary

Transboundary climate risks (TCRs) cross national borders and are associated with the impacts of climate change that (1) propagate through different pathways to affect other countries and regions, and (2) emerge from the effects of climate change adaptation in one or more countries and can have repercussions for others. In an increasingly interconnected world, TCRs can flow through shared ecosystems and resources (through biophysical connections), trade links (through the flow of goods and services), financial interdependencies (through the flow of capital and other assets) and people (through movement).

The island of Ireland is one of the most open economies in the world for trade and finance. While this openness has helped to generate significant wealth and improve living standards, it has also created vulnerabilities associated with being small, open and highly globalised. The Transnational Climate Impacts Index ranks Ireland 68th among the countries most vulnerable to TCRs globally. The island's open economy, trade and finance links make it among the most vulnerable to climate change's impacts on international trade. Coupled with this, the cross-border dimensions of climate change impacts and climate action for the island of Ireland increase the importance of collaboration across jurisdictions.

The Transboundary Climate Risks for the Island of Ireland (TCRII) project undertook a literature review and worked with stakeholders to identify approaches for the assessment of TCRs (Chapter 2) and synergies to leverage on an all-island basis (Chapter 3), and to provide recommendations that enable emerging risks to be better accounted for, to realise the national climate objective of achieving a climate-resilient economy and society by 2050 (Chapter 4). Seven pathways for understanding and adapting to TCRs were identified:

1. **Trade risk pathway:** this relates to the exchange of goods and services across borders, impacting agriculture, food security and other commodities.
2. **Biophysical risk pathway:** this encompasses climate impacts on biodiversity, ecosystems and natural resources, including fisheries and forestry, and the spread of invasive species.
3. **People risk pathway:** this involves changes in the movement of people in response to climate change.
4. **Geopolitical risk pathway:** this encompasses international competition for natural resources, markets and trade routes, potentially leading to new political challenges.
5. **Psychological risk pathway:** this involves the psychological impacts of climate change on people's well-being.
6. **Finance risk pathway:** this encompasses changing capital flows in response to climate change impacts, with implications for businesses engaged in international trade, finance and insurance.
7. **Infrastructure risk pathway:** this encompasses the physical infrastructure connecting countries, such as energy, transport, water and communications networks.

While considering TCRs is relatively new in international policy, Ireland is starting from an advantageous position, with numerous cross-border and international institutions already in place that can be utilised and learned from. For each risk pathway, we worked with stakeholders to complete a first assessment of key vulnerabilities, policy levers and avenues for addressing risks (Chapter 4). The following recommendations emerged:

- **Adopt risk pathways:** recognise and adopt the seven risk pathways for assessing and planning for TCRs.
- **Promote interdisciplinary research:** promote interdisciplinary research across all risk pathways, leveraging all-island research funding partnerships for cross-border collaboration.
- **Leverage cross-border institutions:** engage existing cross-border institutions on an island-of-Ireland scale, such as the North South Ministerial Council and the British-Irish Council.

- **Involve the private sector:** encourage private sector engagement, especially in relation to the trade and finance pathways, to identify and respond to TCRs.
- **Promote international collaboration:** foster international collaboration and partnerships to enhance expertise and awareness regarding TCRs, recognising that risks require global cooperation.
- **Take a whole-of-government approach:** implement a whole-of-government approach, both horizontally (across sectors) and vertically (linking EU, national, sectoral and local levels), to address TCRs effectively.
- **Promote local authority collaboration:** collaborate across the border at the level of local authorities, learning from Derry-Strabane and Donegal, which provide good examples of leadership.
- **Integrate TCRs into national frameworks:** integrate TCRs into Ireland's National Adaptation Framework and establish efficient links with the EU.
- **Develop guidance:** develop user-friendly guidance and evaluation methods to assess and prioritise TCRs in sectoral adaptation plans.

Addressing TCRs is critical for Ireland's resilience to climate change. Assigning responsibilities for understanding and managing TCRs, collaboration and research are essential for adapting to climate change's potential impacts on trade, ecosystems, people and infrastructure.

1 Introduction

1.1 Transboundary Climate Risks

In an increasingly interconnected world, it is widely recognised that no nation can fully shield itself from the effects of climate change, which transcends boundaries and borders. It is now understood that, while the physical effects of climate change are specific to certain regions, the impacts are increasingly felt by people and countries in locations far from the initial impacts. This knowledge necessitates a re-evaluation of our assumptions regarding vulnerability to climate change and how climate risks are propagated across geographical boundaries.

The Paris Agreement acknowledges the reality of the interconnectedness of countries in a globalised world and the need for international collaboration to respond to climate change. As stated in Article 7 of this agreement, responding to climate change is a "global challenge" that has "local, subnational, national, regional, and international dimensions" (UNFCCC, 2015). The agreement calls for international collaboration and assistance to strengthen adaptation efforts, recognising the need for a fresh perspective on the impacts of climate change as well as the design of adaptation strategies.

Climate change impact assessment and adaptation planning have predominantly focused on the assessment of risks and responses within countries. Transboundary climate risks (TCRs) are climate risks that cross national borders (Adams *et al*., 2020) (Figure 1.1). They can comprise (1) the transboundary impacts of climate change and (2) the transboundary effects of adaptation actions, both positive and negative, made by one or more countries, that have repercussions on other countries (Challinor *et al*., 2017, 2018). TCRs can move via shared ecosystems and resources (through biophysical connections), trade links (through the flow of goods and services), financial interdependencies (e.g. through the flow of capital and other assets) and people (through migration or forced displacement) (Benzie *et al*., 2019). These risks can be managed through a variety of management responses that can be categorised into three main approaches: (1) management at source, (2) management along the risk pathway and (3) management at point of impact (Levermann, 2014; Benzie *et al*., 2019; Adams *et al*., 2020; Carter *et al*., 2021). In practice, the best way to manage TCRs is through a combination of all three approaches.

The island of Ireland is one of the most open economies in the world for trade and finance. Historically, access to the European single market has helped to attract inward investment and turn Ireland into a highly globalised economy. While this openness

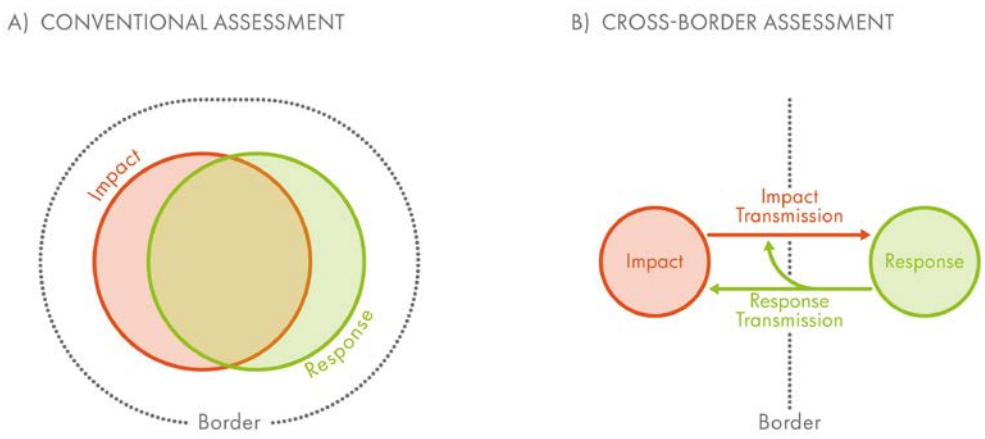

Figure 1.1. Relationship between an impact and response in (A) conventional climate change impacts, adaptation and vulnerability (IAV) assessments, where the impact and response to that impact lie within the same region; and (B) cross-border IAV assessments. Source: reproduced from Carter *et al*. (2021); licensed under CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/).

has helped to generate significant economic wealth and improved living standards, it has also created vulnerabilities associated with being small, open and highly globalised. These characteristics make Ireland vulnerable to TCRs.

In a highly interconnected global society, identifying and managing TCRs is critical to ensuring a resilient and healthy society. As the new EU Strategy on Adaptation to Climate Change highlights, the cross-border dimensions of climate change have regional and/or global repercussions, and Europe will need to actively monitor and mitigate these TCRs to ensure political, economic and environmental stability (EC, 2021). Ireland and Northern Ireland have shared geography and climatic influences, and certain impacts of climate change (e.g. extreme weather events) and the many challenges and opportunities resulting from climate change are likely to be felt on an all-island basis. Moreover, the cascading impacts of climate change on regional and global trade, human security and development outcomes will have implications for policies such as international cooperation, migration, trade and security. The criticality of collaboration across jurisdictions in response to climate change is reflected in the Department of the Taoiseach's Shared Island Dialogue series, in Project Ireland 2040 and in the work of the Climate Adaptation Sub-Committee of the British-Irish Council (BIC).

With these challenges in mind, the Transboundary Climate Risks for the Island of Ireland (TCRII) project explored the key cross-border, transboundary and international impacts of climate change for the island of Ireland. In doing so, the project identifies approaches to the assessment of TCRs and synergies that can be leveraged on an all-island basis, and provides recommendations that can contribute to realising the national climate objective of a climate-resilient economy and society.

1.2 Report Structure

This report is the concluding element of the TCRII project. It is based on multi-stakeholder workshops, literature reviews and an international best practice review of adaptation policy development, with a focus on transboundary impacts and risks. It aims to support the development of effective initiation and implementation of transboundary risk management adaptation policy in Ireland. Chapter 2 outlines the status of TCR assessment and management in other European countries. The approaches to transboundary risk management are examined as well as the pathways through which TCRs may occur. Following this, Chapter 3 examines key transboundary risk pathways for Ireland. Attention is given to seven transmission pathways: trade (agriculture and food supply), biophysical, people, geopolitical, psychological, finance and infrastructure. For each pathway, attention is given to how risks may cascade, existing mechanisms for adaptation, and opportunities and challenges for progressing adaptation policy. The report concludes with a summary of insights from workshops held with key stakeholders from across the island of Ireland and the UK on what makes effective TCR policy. Finally, key conclusions and recommendations from the report are put forward.

2 Transboundary Climate Risk Assessment at the European Level

2.1 Introduction

There is no internationally agreed framework with which to assess and measure TCRs. However, a growing number of studies seek to address this topic. This chapter discusses several recent approaches to TCR assessment and management from a European perspective. The chapter begins by providing an overview of the approaches deployed to date, before briefly outlining research measuring exposure to TCRs in the form of an international climate impact index. This is followed by an analysis of the European-level CASCADES (Cascading Climate Risks: Towards Adaptive and Resilient European Societies) project. The Climate Change Risk Assessments (CCRAs) for the UK are then examined. Following this, the recent and ongoing work of the Adaptation Without Borders Initiative (AWBI), which comprises leaders in the field of TCR research, is discussed. Country-based profiles for Germany and the Nordic countries, which are progressive in their consideration of TCRs, are also briefly outlined. The chapter concludes with an outline of the main pathways put forward by such work, and through which TCRs can propagate.

2.2 Approaches to Transboundary Climate Risk Assessment

International efforts to assess TCRs have been made using various approaches. Harris *et al*. (2022) identified three different approaches in recent literature. The first approach, developed by the Task Force on Climate-Related Financial Disclosures, identifies two categories of climate-related financial risks: physical climate risks, and policy and legal risks. The second approach uses a thematic mapping of transboundary risks that includes five themes – business (trade and investment), infrastructure, food, health and well-being, and foreign policy – as outlined by Reichel (2021). The third approach focuses on risk transmission, with many studies highlighting similar and/or overlapping modes. Benzie *et al*. (2016) outlined four risk transmission pathways: biophysical, finance, people and trade. Hildén *et al*. (2016) classified six categories: biophysical, trade, geopolitical, finance and insurance, movement of people, and infrastructure. Moser and Hart (2015) identified eight pathways: trade and economic exchange, insurance and reinsurance, energy systems, food systems, human health, population migration, communication, and strategic alliances and military interactions. The Third UK Climate Change Risk Assessment Technical Report (CCRA3) (Challinor and Benton, 2021) proposed a framework that identified seven common transmission pathways: energy, finance and markets, governance, information and information technology, movement of goods, movement of people and well-being. These conceptual frameworks are linked by critical flows and provide a comprehensive understanding of how climate risks are transmitted across borders (Benzie *et al*., 2019). They aim to assess and address the risks and transmission modes associated with TCRs.

2.3 Transnational Climate Impacts Index

When TCRs, as opposed to only direct climate risks, are factored into climate risk assessments, the world map of vulnerable nations takes on a different appearance. As presented by Benzie *et al*. (2016), exposure to international transboundary climate impacts has been measured and depicted as a global index known as the Transnational Climate Impacts (TCI) Index. This index comprises key indicators that span four transnational risk transmission routes through which climate risks may disseminate, namely biophysical systems, human mobility, financial flows and international trade. A total of 203 countries are ranked based on TCRs using nine indicators (Benzie *et al*., 2016). As outlined by Benzie and Harris (2020), the results deviate considerably from those obtained using more traditional analyses of vulnerability, such as the Notre Dame Global Adaptation Index (ND-GAIN). ND-GAIN finds that 80% of the most vulnerable countries are nations in Africa and the Middle East. In contrast, the TCI Index reveals that several European nations are among the 30 most

vulnerable to the effects of climate change. While ND-GAIN ranks Ireland as having low vulnerability (rank 142), this increases considerably when TCRs are considered, with the TCI Index ranking Ireland within the top 70 most vulnerable countries (rank 68). Globally, Ireland ranks as among the most exposed to TCRs for international trade (Figure 2.1).

2.4 The CASCADES Project

The CASCADES project is a European Commission project under the Horizon 2020 research and innovation programme, involving 12 international partners and led by the Potsdam Institute for Climate Impact Research, Germany, and Chatham House, UK (Chatham House, 2022). The CASCADES project investigates how climate change impacts arising in other countries may cascade into Europe, heightening climate risks and threatening European stability and cohesiveness. Adapting to such disruptions will necessitate both understanding the transboundary nature of such climate impacts and developing responses to address them. Therefore, the CASCADES project seeks to develop a conceptual framework for describing and assessing cross-border climate change impacts and their associated risks (Carter *et al*., 2021; CASCADES, 2022a,b). The CASCADES project seeks to produce knowledge and resources to assist policymaking and decision-making processes related to cross-border climate risks, and, in doing so, enhance Europe's ability to achieve greater resilience and sustainability.

The CASCADES project employs cutting-edge research methodologies and techniques involving stakeholder collaboration (CASCADES, 2022b). It included a thorough risk assessment as well as detailed studies of economic, value chain, financial and political ties between Europe and the rest of the world. The CASCADES project combines new and established qualitative and quantitative methodologies from both science and social sciences. Innovative methods include the use of collaborative policy simulations; economic- and process-based models; cross-sectoral, network and policy analysis; and statistical analysis of existing records. Focus groups, interviews, theme-based workshops and gender analysis were also integrated into a common scenario framework (Hocquet, 2021). Scenarios of dramatic events caused by the climate crisis, ranging from global food security/agricultural emergencies to

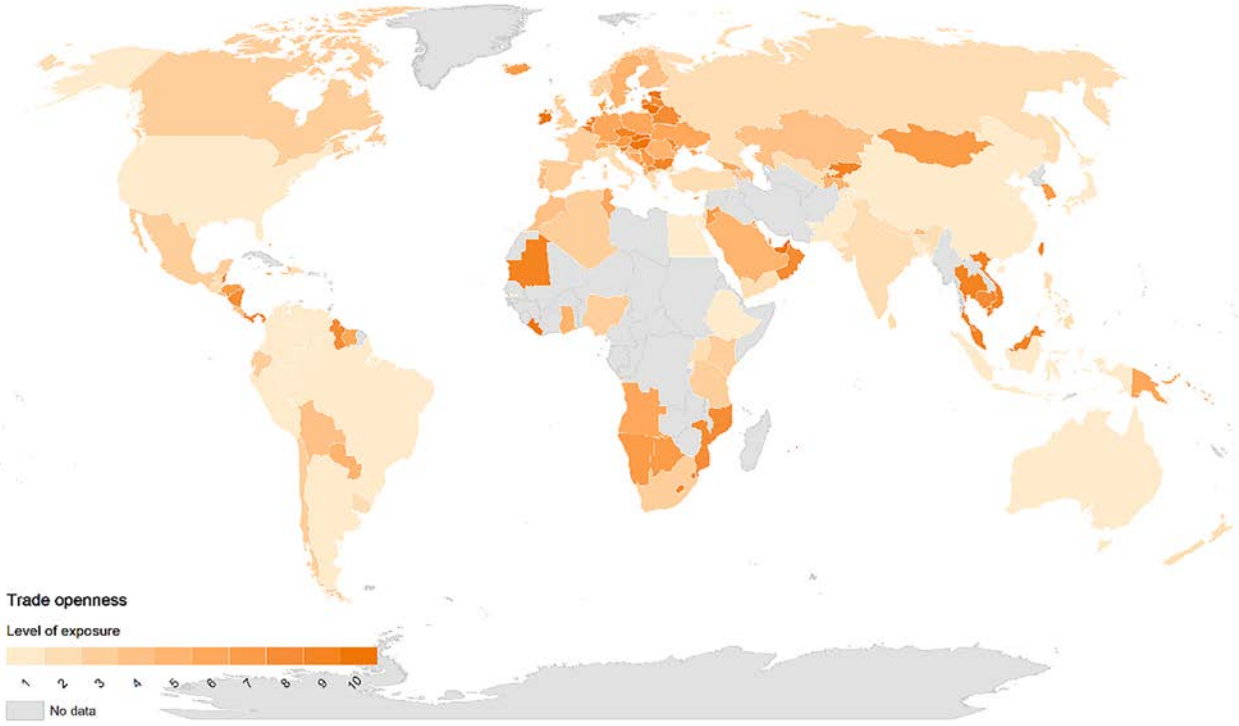

Figure 2.1. Exposure map showing TCRs due to trade openness. Darker colours indicate higher exposure, with Ireland ranking among the world's most exposed countries to transboundary climate impacts on trade. Source: Benzie *et al*. (2016).

disruptions to trade and supply chains, were presented to participants. Working groups were set up for participants to discuss and apply their expertise and knowledge on how to mitigate the unfolding crises.

According to CASCADES (2022b), such methods enable the consideration of socio-economic impacts, physical infrastructural damage, dynamic disease and nutritional patterns, forced migration, disruption to trade and financial markets, political instability and conflict. The project researchers propose that a combination of such methods, within a multidisciplinary setting, is essential for gaining a comprehensive understanding of climate impacts, particularly in a transboundary context.

2.5 The UK Climate Change Risk Assessments

In 2021, the UK Committee on Climate Change published CCRA3. Chapter 7 of the CCRA3 Technical Report assessed the transboundary risks of climate change for the UK (Challinor and Benton, 2021). A previous assessment of risks relating to international dimensions (Challinor *et al*., 2016) was published in 2016 as part of the second CCRA. Challinor and Benton (2021) presented a framework for assessing TCRs, drawing information from different sources (Moser and Hart, 2015; Benzie *et al*., 2016; Challinor *et al*., 2016, 2018; IRGC, 2018). The framework identifies the seven most prevalent risk transmission pathways for the UK: energy, finance and markets, governance, information and information technology, movement of goods, movement of people, and well-being. The report also demonstrates that feedback from the UK's own climate risk response could both cause and exacerbate risks internationally.

The framework presented by Challinor and Benton (2021) lays out a method for reviewing the key risks identified by the CCRA team, following the approach of Watkiss and Betts (2021) outlined in Chapter 2 of the CCRA3 Technical Report. However, the method was found to be more challenging to apply to international transboundary assessment than to national assessments. This was also demonstrated across all four jurisdictions of the UK (Scotland, England, Wales and Northern Ireland). Risks and opportunities were found to vary in each country, thus warranting further, separate, analyses.

The methodological approach applied by Challinor and Benton (2021) can be summarised as follows. First, the current and potential future risks and opportunities relating to climate and socio-economic change were analysed, with initial scores of their magnitude given. Each of the UK jurisdictions was scored separately. Second, an evaluation was undertaken to determine the impact that adaptation measures may have on mitigating current and future climate change risks and enhancing potential opportunities. This established whether or not risks and opportunities are being managed, and identified challenges that may be preventing adaptation measures from succeeding. Third, the potential benefits and costs of any further adaptative action required were identified and assessed. Risks and opportunities were scored and categorised as either more urgent ("more action needed" or "further investigation") or less urgent ("sustain current action" or "watching brief"). Last, further data and analysis that address risks and opportunities, and that may be valuable in guiding the UK National Adaptation Programme and subsequent risk assessments, were outlined. This included identifying where transformational adaptation strategies may be implemented.

2.6 Adaptation Without Borders Initiative

Advocating for international cooperation in relation to TCRs, the UK Foreign Office's International Science and Innovation Network has formed a working partnership, known as the AWBI, to move TCRs to the forefront of research efforts. The AWBI is a collaboration between the Overseas Development Institute, Stockholm Environment Institute and the Institute for Sustainable Development and International Relations. It was funded by the European Prosperity Fund of the then UK Foreign and Commonwealth Office (now the UK Foreign, Commonwealth and Development Office) and brings together globally recognised experts and partners from across four continents (Adaptation Without Borders, 2022a,b).

The AWBI is based on the recognition that climate change impacts necessitate adaptation efforts that stem from the collective efforts of the global community as opposed to the efforts of single governments working alone (Adaptation Without Borders, 2022a). Therefore, the AWBI aims to identify and assess TCRs

and support policymakers, planners and the private sector in the development of international solutions for cascading climate risks. The initiative seeks to create the necessary impetus to motivate the development of such solutions through communications, events and targeted policy engagement with policymakers, planners and stakeholders (Adaptation Without Borders, 2022b). It is built on four pillars: creating visibility, building connections, gathering evidence and inspiring action. The AWBI also intends to improve the understanding and raise awareness of the interdependence of wealthy and poorer nations in terms of climate risks and finds that climate impacts could cross national borders and impact other countries via four risk pathways: biophysical, trade, people and finance.

A recent study by Harris *et al*. (2022), involving researchers associated with the AWBI, illustrates that while existing climate risk assessment frameworks have merits they also have limitations that make them unsuitable for investigating transboundary climate threats. As a result, the study presents a novel analytical technique in the form of a seven-step process that permits the analysis of TCRs via case study-based adaptation research. This approach enhances the identification, assessment and evaluation of TCRs, resulting in a more effective, thorough and just approach to adaptation. The technique employs an improved impact chain framework. The protocol also permits the creation of new perspectives for managing complicated risks and investigates an essential TCR concern, namely that of risk ownership.

2.7 Country-based Profiles

2.7.1 Nordic countries

Most of the Nordic countries (Sweden, Finland, Norway, Denmark and Iceland) are recognised as pioneers in climate policies, but primarily at an individual country level. Finland and Sweden are, however, further along than the other nations in addressing TCRs. Their economies are heavily reliant on imports and exports, making them susceptible to the effects of TCRs (Berninger *et al*., 2022). As early as 2005, Finland's first national adaptation strategy recognised that climate change in other regions could have implications for the country, with subsequent reports examining its effects. The National Climate Change Adaptation Plan 2022 examined TCRs and opportunities for Finland, while other recent studies have analysed various concerns, such as national security and migration (Prokkola *et al*., 2021; Hakala *et al*., 2022).

Similarly, several Swedish studies have examined transboundary climate impacts. Mobjörk (2012) analysed the impacts of climate change on national security, while, as noted by Berninger *et al*. (2022), more recent studies have explored value chains, trade and other transboundary impacts. A multi-method approach was developed by Lager and Benzie (2022), which identified and assessed TCRs through Sweden's international trade links. A traditional assessment method used statistical trade data, while a second innovative approach assessed supply chain risk, with a focus on a key imported commodity, soy, from Brazil. The second approach pointed to TCRs for Swedish imports from climate-vulnerable countries, with results disagreeing with the first approach's relatively reassuring picture. This discrepancy arose because of the way in which commodities are assigned to their country of origin. For example, 60% of soy products originating from Brazil are recorded as being imported from Norway, as they reach Sweden through Norway. Schultze *et al*. (2022) highlighted Sweden's dependence on exports and imports, finding that the country lacks self-sufficiency in some products, which could result in possible disruptions to various supply chains.

In 2013, the Danish government launched a report on the effects of climate change on the country's security, economy and social structure. More recent reports have focused on risks associated with Denmark's dependence on imported goods and services, particularly from vulnerable regions. For example, a report by Bosselmann *et al*. (2020) examined the risks associated with Danish imports of soy and palm oil, both of which are linked to deforestation in tropical forest regions. The report emphasised the need for Denmark to have a more sustainable approach to trade and support sustainable production in producer countries. Similarly, a report by the Danish Council on Climate Change in 2021 highlighted the risks associated with the country's dependence on imported food and the need for a more sustainable food system.

A study by Berninger *et al*. (2022) provides a recent account of TCRs in Nordic countries and provides valuable insight into strategies for assessing TCRs. The study investigated the understanding of TCRs and related policies by reviewing papers in academic journals and policy reports for each of the Nordic countries. In addition, it delved into the mechanisms of TCR transmission using Carter *et al*.'s (2021) seven pathways, namely trade, finance, people, psychological, geopolitical, biophysical and infrastructure. The study also examined literature relating to TCRs for the Nordic countries in various economic sectors. To gain further insight, online semistructured interviews were conducted with researchers and public and private sector representatives, which explored opportunities for inter-country collaboration. Following this, the methods of Lager and Benzie's (2022) assessment were employed to analyse trade flows, with the aim of assessing Nordic exposure to potential climate risks in various sectors and supply chains.

An in-depth sector analysis was carried out on the agriculture and food production sector, based on insights derived from the review, interviews and trade data, which identified risks based on their priority, likelihood, magnitude and available data. The sector analysis included a quantitative evaluation of climate risks associated with trade inputs, and further interviews were conducted to explore risk awareness, ownership and the potential for addressing risks and promoting collaborative action among Nordic countries. The interviews were primarily focused on private sector actors, but also included government officials, farmers and other experts (Berninger *et al*., 2022).

Berninger *et al*. (2022) suggested that Nordic countries share common traits, such as having advanced climate adaptation expertise, intergovernmental bodies and open economies, which could be leveraged for collaboration on raising awareness, facilitating research and sharing best practices to address TCRs. Joint initiatives in the energy, transport and food sectors could be useful for sharing costs and securing ownership. However, Nordic countries have varying levels of preparedness for and approaches to addressing TCRs. While some countries and sectors are more advanced than others, TCRs are still given low priority in adaptation policy across the region. Increased collaboration and communication among governments, businesses and society are needed to increase awareness, assess risks and address the costs and cross-sectoral impacts of TCRs in the Nordic region. Future research recommendations include exploring the allocation of ownership and responsibility for managing TCRs, particularly in relation to trade and finance, as well as the role of local and regional authorities in addressing such risks.

2.7.2 Germany

Several studies have been completed in relation to TCRs for Germany, particularly on the impacts of trade flows resulting from vulnerable export and import countries, which will be affected by climate change. Some of these studies exhibit a more quantitative approach to TCR assessment. Osberghaus (2019) suggested that the destruction of transport infrastructure and production processes in the agriculture and manufacturing sectors could have adverse impacts on Germany's trade flow. Similarly, climate-induced income fluctuations in vulnerable countries could lead to decreased demand for goods imported from Germany.

Peter *et al*. (2019, 2021) used impact chains to assess how Germany is exposed to TCRs through trade links. The project identified several impact chains that could potentially have adverse effects on Germany's economy and society because of TCRs. The most relevant impact chains were further investigated using a macroeconomic model, and adaptation strategies were developed for those with the most significant effects. The study also evaluated Germany's import and export trading partners and identified 12 countries or regions that are particularly vulnerable to climate change based on ND-GAIN (Peter *et al*., 2021).

Wolf *et al*. (2021) compiled a sectoral report as part of the Climate Change Impact and Risk Assessment 2021 and concluded that some imports face medium climate risks, even under optimistic climate change scenarios. However, they found that risks are lower for exports and the transportation of goods. This finding is consistent with the findings of Peter *et al*. (2019), which suggest that, while some risks may exist for imports, an increase in exports could represent an opportunity for certain sectors and industries. Reichel's (2021) stakeholder analysis of TCRs for Germany reveals that global financial markets have the most significant influence on TCRs for the country's trade

and production activities. Reichel interviewed eight stakeholders from various private and public sector organisations involved in TCR management to gain an understanding of their views on TCRs related to their field of work, existing actions being undertaken in TCR risk management and opportunities for and barriers to their engagement in the future.

Peter *et al*. (2021) found that climate change impacts on Germany's economy are mostly through global trade, particularly from regions outside Europe. To mitigate these impacts, they recommend diversifying international trade and providing targeted support for adaptation measures in vulnerable countries. However, Reichel (2021) warned that the transition to green markets may pose risks to German exports, with some industries becoming unsustainable. The study highlights the significant negative effects of changes in labour productivity and agricultural yields and rising sea levels on purchasing power in China, India, South and Southeast Asia, the Middle East and Africa. Imports to Germany are impacted more than exports, with the services and construction sectors experiencing lower demand and the machinery and electronic equipment sectors experiencing higher demand. The study underscores that TCRs through foreign trade are as significant as the economic effects of climate change within national borders.

2.8 Pathways of Risk Transfer

Most assessments of TCRs follow similar impact pathways to identify mechanisms that can transfer climate risks from one country to another. These impact pathways can include risks related to trade, which encompasses agriculture, food supply and other commodities, and biophysical, financial, geopolitical, psychological and infrastructure-related risks. Several northern and western European countries, namely Finland, Germany, the Netherlands, Norway, Sweden, Switzerland and the UK, have carried out transboundary assessments by utilising such frameworks and integrating some or all these risk pathways. In the context of transboundary risk assessment for the island of Ireland, therefore, the risk pathways outlined by Carter *et al*. (2021) will be followed. These pathways are described in the following sections and can be characterised by the ways in which climate change impacts different sectors and socio-economic systems. Transboundary risk pathways function on two distinct geographical levels: transboundary impacts occur across borders of adjacent countries, while teleconnected impacts arise from more distant connections spanning greater distances.

The **trade risk pathway** encompasses the exchange of goods and services across borders through international supply chains and global markets. TCRs associated with trade can relate to agriculture and food security, as well as other commodities, and are likely to involve cross-border impacts on the import and export of goods.

The **biophysical risk pathway** encompasses the impact of climate change on biodiversity, ecosystems, natural resources and vector-borne diseases. Biophysical risks refer to a wide range of environmental risks generated through interactions between plant and animal life and the geophysical environment (Smith, 2013). TCRs associated with biodiversity can include impacts on fisheries and forestry, and the spread of invasive species, pests and pathogens. This pathway can also encompass changing flows of water resources from transboundary ecosystems such as river basins, oceans and the atmosphere (Carter *et al*., 2021).

The **people risk pathway** encompasses the movement of people across borders due to climate-related impacts, such as sea level rise or drought, and social and political tensions that can escalate into violent conflict and put strain on public services and infrastructure. Furthermore, changes in tourism patterns can also impact natural resources, cultural heritage and amenities, potentially exacerbating existing social and economic disparities.

Geopolitical risks refer to threats, events or the amplification of risks associated with violent conflict, terrorism and tension between nations and that impact international relations and security (Caldara and Lacoviello, 2022). Therefore, the **geopolitical risk pathway** associated with climate change can relate to international competition between countries for access to natural resources, markets and strategic trade routes (Carter *et al*., 2021). According to Climate Northern Ireland (2021), geopolitical risks are likely to occur in tandem with other transboundary risk pathways and are recognised as amplifying already existing conflict. They can range from diplomatic

disagreements between countries to violent conflict and have global economic consequences. Such risks can include border and sovereignty disputes that threaten national and international security.

The **psychological risk pathway** describes the impacts that TCRs have on people's well-being and how such risks are perceived and communicated. The impacts include those brought about by the actions of different actors, particularly the media, based on their perceptions and communication of cross-border risks and opportunities (Carter *et al*., 2021). The importance of people's perceptions and awareness of TCRs is described as a "cognitive chain of influence" or "cognitive filter" (Hildén *et al*., 2016; Benzie *et al*., 2019). This refers to the complex nature of psychological impacts and their interrelation with all other TCR pathways, and the way in which such challenges and issues are viewed and understood.

The **finance risk pathway** pertains to changes in public and private capital flows (Carter *et al*., 2021). These risks primarily affect companies and businesses engaged in international value chains, finance and insurance (Berninger *et al*., 2022). Such risks encompass the depreciation of assets due to climate-related impacts and the heightened expenses for insurance companies and banks. Examples of assets include foreign direct investment and remittances (Challinor and Benton, 2021).

The **infrastructure risk pathway** refers to the physical infrastructure that connects countries, such as energy, transport, water and communications networks. Critical infrastructure is vital for the functioning of a nation to ensure the delivery and maintenance of important services in society. Furthermore, these networks exhibit a high degree of interdependency on each other (Rinaldi *et al*., 2001). Extreme weather events can cause disruptions to infrastructure networks and societal functions, which can transmit across borders, and can increase maintenance costs and risks to public safety. Impacts such as flooding and erosion can have consequences for energy supplies; the movement of people, goods and services; communications and information and communications technology (ICT) systems; and water storage and supply.

3 Transboundary Climate Risks and Policy for the Island of Ireland

3.1 Introduction

Based on a review of academic literature, projects and policies at a European level, and workshops with stakeholders, this chapter explores the key TCR pathways for Ireland. Attention is given to seven transmission pathways: trade (agriculture and food supply), biophysical, people, geopolitical, psychological, finance and infrastructure. For each pathway, key risks, mechanisms for policy and adaptation, and key opportunities and challenges are highlighted. These assessments are not exhaustive, but rather act as a starting point for assessing TCRs and adaptation in Ireland. Much more research is required. The chapter closes by highlighting the importance of collaboration between government and the private sector in addressing TCRs.

3.2 The Trade Risk Pathway: Agriculture and Food Supply

Climate changes on an international scale can impact trade and food production patterns, resulting in changes in productivity and land suitable for producing food (Challinor and Benton, 2021; Climate Northern Ireland, 2021). Such risks may lead to price hikes, disruptions to supply chains and trade, issues with transport infrastructure and a reduction in the availability of goods or services. Furthermore, price hikes can result in food contamination or the replacement of high-quality foods with cheaper, lower-quality, alternatives (Challinor *et al*., 2017). CCRA3 highlights that such risks are likely to be of concern for the UK and Northern Ireland (Challinor and Benton, 2021; Climate Northern Ireland, 2021), and it is likely that Ireland will face similar challenges.

Ireland's agri-food exports account for 90% of food production and 9.5% of total exports to 180 countries (DAFM, 2022), with 80–90% of these exports coming from the dairy and beef sectors. One-third of food and beverage exports are destined for the UK, another one-third for the EU and the rest for various international markets such as China, Japan, Southeast Asia, Africa and North America (Bord Bia, 2022), with some regions highly vulnerable to climate changes. Despite being a major exporter, Ireland relies heavily on imports, with up to 80% of vegetables, fruits, grains, fertiliser and animal feed being imported from, among other countries, Argentina, the USA, Russia and Paraguay (CSO, 2019; ITA, 2022). While Ireland is considered food secure, it is not self-sufficient in terms of food production (Hanrahan, 2022). This puts Ireland at risk of food supply chain disruptions, especially in the event of market shocks (DAFM, 2022).

While the UK and Northern Ireland do not see food availability as an immediate threat, there are concerns over the accessibility of food, particularly among the economically marginalised (Challinor and Benton, 2021; Climate Northern Ireland, 2021). Ireland is also vulnerable to such risks, with households on low and fixed incomes vulnerable to food price fluctuations and associated food security challenges. While membership of the EU provides access to integrated food markets, recent extreme drought conditions in southern Europe have seen shortages of fruit and vegetables across the EU and increased costs for the consumer (e.g. Scally, 2022). In addition, severe weather conditions in Ireland have presented challenges for the dairy sector in the form of fodder crises such as those experienced in 1998/99, in 2012/13 and most recently in 2018. In 2018, widespread drought conditions across much of northern Europe hampered access to the import markets needed to improve fodder stocks, adding additional challenges and emphasising the cross-border impacts of regional-scale drought and the need for coordinated response at the international (EU) level (Cadogan, 2018). Other non-climate factors can increase vulnerabilities to climate-related transboundary risks, as is evident from the war in Ukraine, which resulted in significant price increases for feed, fertilisers and fuel, and in a considerable rise in total production costs for the agri-food sector, making the sector more sensitive to any climate extremes.

On the island of Ireland, cross-border trade is critical to both economies. A significant portion of cross-border

trade involves businesses trading in both directions (Studnicka and Lawless, 2018), and the trading of up to 66% of goods across the border is due to supply chain activity. An estimated 23,000–30,000 people are cross-border workers (Sergeant, 2020).

3.2.1 Mechanisms for policy and adaptation

There are several existing mechanisms for policy generation relating to TCRs for trade between Northern Ireland and Ireland and between the island of Ireland and the rest of the world. At the national level, effective coordination between government departments is crucial for transboundary food security and trade policies for both Ireland and Northern Ireland. In Ireland, the Department of Agriculture, Food and the Marine and the Department of Health are responsible for policy and decision-making relating to food supply and health, supported by the Food Safety Authority of Ireland and other competent authorities designated by the Department of Health (Keenan, 2018).

In Northern Ireland, food supply matters are overseen by the Department of Agriculture, Environment and Rural Affairs (DAERA), while public health is the responsibility of the Department of Health. The Food Standards Agency is responsible for food safety and consumers' interests and ensures that certain standards for imported and exported food are met. Trade-related matters are handled by DAERA and the Department of the Economy. Existing government structures such as the North South Ministerial Council (NSMC) and BIC, as well as formal and informal relationships or networks, can support adaptation planning efforts. Developing cross-border legislation and political mandates for transboundary climate issues relating to trade will be crucial for effective collaboration in areas of mutual interest (Climate Northern Ireland, 2021).

3.2.2 Opportunities and challenges

As highlighted by studies conducted in other jurisdictions (Peter *et al*., 2020), diversifying international supply chains and forming new trading partnerships can reduce Ireland's dependence on specific countries, making the economy more resilient to global and domestic price shocks. Climate Northern Ireland (2021) also recognises the importance of accessing a wide range of international markets, which can create opportunities for Irish businesses to develop new trade relationships. Furthermore, Chapter 7 of the CCRA3 Evidence Report explains that having access to alternative markets can provide resilience to external shocks arising from international transboundary climate impacts (Challinor *et al*., 2016).

To reduce reliance on specific countries or regions for trade, Ireland could consider expanding local food production. As noted by the Environmental Pillar (2022), Ireland's dependence on imported tillage crops has risen because of an increase in demand to levels that exceed domestic supply. Many of these crops can already be grown domestically, and a wide variety of vegetables and fruits can also be cultivated in Ireland. This presents economic opportunities for the tillage sector to increase production and enhance the country's self-sufficiency. Food Vision 2030 recognises the importance of primary producers, diversification, and social and environmental sustainability in realising resilient food systems. The Environmental Pillar (2022) notes that achieving greater self-sufficiency in food production would require changes in Ireland's agricultural practices. Currently, many tillage methods in the country can harm soil diversity and function, leading to lower organic matter and carbon levels. Moreover, most of the produce is directed towards the animal feed industry. Therefore, a shift towards greater tillage farming would necessitate policies that prioritise organic production methods and increase the amount of food grown specifically for human consumption.

According to Willett *et al*. (2019), the EAT-Lancet Commission on Food, Planet, Health recommends a radical transformation of the global food system by 2050, and advocates for a move towards a more plant-based diet. Therefore, as consumer preferences change, demand for agri-food products will reflect a move towards more sustainable and environmentally aware produce, and a reduction in the consumption of meat and a trend towards plant-based diets. While this presents an opportunity for the tillage sector, there will be a need to manage the inevitable changes and opportunities presenting to meet such demand (DAFM, 2022). However, consideration must be given to the impact that this may have on Ireland's beef export industry.

A lack of understanding and knowledge of TCRs and the pathways of impact for trade is a key barrier to

effective transboundary climate policy for the island of Ireland. Expert researchers and policymakers familiar with trade, supply chains and economics will be required to identify and assess Ireland's dependence on foreign trade in terms of procurement, services and raw materials. However, shifting the focus of climate adaptation onto transboundary risks will require more than the participation of academic researchers and government personnel. Supply chain issues and trade restrictions that may arise from TCRs will primarily impact the private sector and business enterprises. Therefore, corporate stakeholders must be involved in evaluating risks and formulating appropriate policy measures.

Trade can create opportunities for collaboration and economic links. However, as TCRs may weaken and disrupt trade agreements, it is crucial to ensure that such agreements are supported at the national level. Effective transboundary climate policy requires policies that flow from the international level to the national and local levels, aligning with, rather than undermining, domestic policy, to achieve greater climate resilience. Brexit has given rise to increased concerns about transboundary trade on the island of Ireland, making cross-border collaboration crucial for developing policies that address areas of mutual interest. Differences in policies and legislation may lead to ineffective adaptation between Northern Ireland and Ireland. Therefore, policy that addresses transboundary climate issues, with clear political mandates, is necessary. Existing government structures, such as the NSMC and BIC, as well as formal and informal networks can support these efforts.

3.3 The Biophysical Risk Pathway

The island of Ireland is confronted with a range of biophysical risks, including transboundary threats from invasive species, infectious diseases in plants and animals, and impacts on existing water bodies and river basins. While some measures have been put in place to address these risks, they continue to pose a significant threat to the island of Ireland's biodiversity, ecosystems and water resources. The movement of people and goods between neighbouring jurisdictions and across international borders can aggravate the spread of invasive species and infectious diseases, potentially affecting the agriculture and forestry sectors and increasing the use of pesticides.

Birds, through migration, connect Ireland's ecosystems with those of the rest of the world, and, therefore, bird migration across borders risks the spread of infectious diseases. Ireland serves as an important wintering ground for migrating waterbirds, which breed in more northern latitudes but migrate southwards to spend the winter on Irish coastal areas, rivers and lakes (Crowe *et al*., 2012; Burke *et al*., 2018). Furthermore, many avian species migrate northwards to Ireland for the summer months (Lewis *et al.*, 2019). Species also migrate across both jurisdictions on the island of Ireland. Although the risk to human health has been deemed to be very low, outbreaks of diseases, such as avian flu, that are highly contagious among wild birds pose a serious threat to captive birds and poultry.

Climate change is resulting in shifts in migratory behaviour, with many species no longer having to migrate as far south as Ireland to find ice-free wetlands (Burke *et al*., 2018). Since the 1990s, there has been a 40% decline in waterbird species migrating to Ireland, partly attributed to less suitable conditions on breeding grounds, resulting in poorer breeding success. As predators and dispersers of other species, seeds and nutrients, waterbirds contribute significantly to ecosystem services such as pest management and diversity enhancement, serving as important bioindicators of the habitat's natural health (Green and Elmberg, 2014). There is, therefore, a need to monitor and manage the risk of infectious diseases that are spread by migrating birds at both the domestic and international levels.

While the primary mechanism for species movement is through transport on trading ships, many land-based species will respond to a warming climate by migrating northwards and colonising new areas (Climate Northern Ireland, 2021). Ireland's National Adaptation Framework (NAF) states that projected changes in climate both in Ireland and elsewhere aid the establishment of invasive species, which in turn increases competitive pressures for native species (DCCAE, 2018). Invasive species can have a negative impact on biodiversity, ecosystem function, agriculture and forestry (EPA, 2017). Therefore, the emergence of new pests, diseases and invasive non-native species

(INNS) is an important TCR because of its potential negative effects on the environment and economy.

CCRA3 places the risk of INNS at a magnitude of medium by the 2050s and high by the 2080s for a scenario where global temperatures increase by 4°C by 2100 (Climate Northern Ireland, 2021). The magnitude of risk for marine and freshwater species is also predicted to increase from medium at present to high in the future, although uncertainties exist. The current pattern of the northward movement of fish species, resulting in the replacement of cold-water species with warm-water species, is expected to continue (Climate Northern Ireland, 2021).

Once invasive species and pests have been established, they can be difficult and costly to control or eradicate (Deignan *et al*., 2019). In 2013, the direct annual cost of INNS to the island of Ireland's economies was estimated to be €261 million (Kelly *et al*., 2013; DCHG, 2017). According to Lucy *et al*. (2021), a further economic analysis in 2021 indicates that, without intervention, costs will rise by 2030. Such issues may also impact the agri-food sector by reducing the availability of ingredients for the food and beverage sectors (Deignan *et al*., 2019).

While species migration can occur as a result of climate changes, it often involves other drivers, such as cross-border trade, movement within countries, biosecurity measures, overexploitation and land use change (Climate Northern Ireland, 2021). These drivers can be interrelated, and therefore species movement is complex in nature. However, not all new species may interact negatively with existing biodiversity, with some enhancing species richness and contributing to community adaptation to climate change (Climate Northern Ireland, 2021). Nevertheless, the emergence of new and invasive species remains an important consideration for TCRs on the island of Ireland.

The management of shared river basins and groundwater bodies is a critical component of water resource management, particularly in the context of climate change. The EU Water Framework Directive requires the implementation of river basin management plans that promote the sustainable use and management of water resources. According to Climate Northern Ireland (2021), there are three shared international river basin districts: the Neagh Bann District, the North-western District and a small part of the Shannon Basin District. In addition, there are 34 transboundary groundwater bodies shared between Northern Ireland and Ireland. While Northern Ireland and Ireland do not currently abstract significant volumes of groundwater from existing aquifers, climate change is increasing stresses on water resources. However, the impacts of climate change have the potential to exacerbate challenges relating to the management of shared water resources, such as over-abstraction, pollution and the loss of aquatic biodiversity.

3.3.1 Mechanisms for policy and adaptation

At the international level, Ireland is committed to implementing and reporting on the Global Biodiversity Framework through the UN Convention on Biological Diversity (DCHG, 2017), with specific actions aimed at eradicating and controlling invasive alien species and reducing rates of introduction and establishment. At the EU level, a regulation (Regulation (EU) No. 1143/2014) on the introduction and spread of invasive alien species establishes a more consistent approach to tackling invasive species across Member States and provides a list of species of concern, which is regularly updated. At the national level, the National Biodiversity Action Plan for Ireland acknowledges the role of climate change in its objectives, targets and actions. Similarly, the Climate Action Plan 2023 recognises the importance of biodiversity in achieving its goals. The Biodiversity Climate Change Sectoral Adaptation Plan (DCHG, 2019) emphasises the need for an all-island programme to monitor the spread of invasive species.

The Department of Agriculture, Food and the Marine's sectoral adaptation plan for agriculture, forestry and seafood (DAFM, 2019) addresses cross-border issues related to marine invasive species and highlights the economic damage caused by harmful algal blooms. In addition, the All-Island Climate and Biodiversity Research Network (AICBRN) facilitates collaborative research on climate and biodiversity across Ireland, while the National Biodiversity Data Centre collects, organises and reports on data related to the country's biodiversity. Furthermore, as part of the Water Framework Directive, the draft river basin management plan for Ireland (2022–2027) highlights five actions targeted at invasive alien species: the

finalisation of legislation to implement EU regulations, the preparation of action plans for priority species, the recruitment of biodiversity officers, the provision of additional funding for tackling priority species and community-level action. However, for cross-border catchments, collaborative efforts between Northern Ireland and Ireland to manage shared water bodies needs to be prioritised (DHLGH, 2018). At the local level, biodiversity concerns are also addressed in each local authority plan for Ireland. Other policy generation mechanisms include Northern Ireland's Local Government Climate Change Network (Climate Northern Ireland, 2021) and the All-Ireland Pollinator Plan implemented by the National Biodiversity Data Centre.

3.3.2 Opportunities and challenges

To ensure successful adaptation, collaborative action will require planning across multiple sectors as well as both bottom-up and top-down approaches. According to the Environmental Pillar (2022), it is essential to leverage the benefits of all-island cooperation, EU membership and international agreements, to prioritise a transboundary focus. An all-island conservation strategy would provide advantages for both biodiversity and ecosystems, while also strengthening the relationship between the two jurisdictions. Furthermore, the management of transboundary species should encourage cross-border collaboration on conservation efforts.

To effectively address and implement transboundary climate policy for biophysical risk, collaboration with existing groups and partnerships between Northern Ireland and Ireland are essential. This approach can help to avoid the duplication of work and identify key differences in policy or legislation. Many initiatives and partnerships exist, including research networks such as the AICBRN and the Northwest Strategic Partnership. The Taoiseach's Shared Island Initiative (SII) is also a mechanism that could support cross-border resource management. In addition, capacity building within institutions can enable collaborative efforts and ensure effective transboundary climate policy. High-risk invasive species should be prioritised for control, and integrated approaches for their management should be identified. As highlighted by Kelly *et al*. (2013), investment in biosecurity measures to prevent the arrival of new invasive species is paramount, and early intervention is critical for reducing impacts on biodiversity and costs associated with long-term control and management.

The Irish government's commitment to increasing the Marine Protected Area (MPA) network to 30% by 2030 presents a potential avenue for collaboration between the island of Ireland, the UK and the EU, in the management and designation of sites aimed at safeguarding transboundary marine species (Environmental Pillar, 2022). In this regard, Bord Iascaigh Mhara is undertaking a significant programme of work geared towards addressing marine invasive species. It is crucial that such efforts are integrated into the National Biodiversity Adaptation Plan to achieve coherence in the overall approach towards expanding the MPA network and the conservation of marine species.

To effectively address the negative impacts of INNS on biodiversity and water quality, a better understanding of their effects is necessary. However, the lack of resources, research and funding presents a significant challenge to developing effective transboundary climate policy. In addition, political and economic instability, and changes in government leadership, can lead to a lack of sustained investment and coherent legislation. Nevertheless, it is crucial to prioritise significant funding for research and development to prevent damage to our environment and economy by INNS. The absence of timely intervention and targeted biosecurity strategies is a significant contributing factor to current INNS-related issues in Ireland (Lucy *et al*., 2021). Therefore, investment in controlling and eliminating harmful INNS is urgently needed to prevent irreversible losses of native species and reduce potential substantial costs (Climate Northern Ireland, 2021). As outlined by Lucy *et al*. (2021), such measures should include the establishment of an invasive species management division in Ireland; the development of a national biosecurity strategy; the provision of training, support and resources for customs services at Irish ports and entry points; the development of management and contingency plans for current and future INNS in Ireland; the surveillance monitoring of water bodies; and the creation of national education and awareness programmes.

At present, transboundary water bodies on the island of Ireland are managed jointly through the EU Water Framework Directive. However, uncertainties in light of

Brexit and future UK environmental policy are evident. This could result in more complex arrangements for cross-border cooperation and consultation in the future. Ireland's river basin management plan for 2022–2027 will need to consider the risks associated with flooding and water quality in shared river catchments and water bodies between both jurisdictions.

The collecting and sharing of data are crucial for effective transboundary climate policy, especially concerning biophysical risks. However, a lack of accessible data has been identified as a challenge. To address this issue, the National Biodiversity Plan 2017–2021 recommended the creation of a comprehensive database that includes all non-native species introduced to the island of Ireland (DCHG, 2017). Such databases can provide a better understanding of general trends on the island of Ireland, and facilitate the identification of the long-term impacts of invasive species, which is essential for developing policies for biodiversity restoration and protection on the island of Ireland.

3.4 The People Risk Pathway

On the island of Ireland, the people-centred pathway is likely to encompass transboundary risks relating to physical and mental health, forced migration and displacement and tourism changes. TCRs along the people-centred pathway are associated with forced migration and displacement due to the cascading impacts of climate change hazards, such as heat, floods, droughts and reduced precipitation. These hazards can increase competition for and conflict related to scarce resources, and threaten livelihoods and health in vulnerable countries (Opitz-Stapleton *et al*., 2021). In regions such as the Sahel in Africa, climatic changes, food poverty, dwindling resources, governance and discrimination against pastoral people have been associated with the forced displacement of people (Cepero *et al*., 2021). While much of this forced migration is to neighbouring regions, a rise in migration towards Europe is anticipated (Knaepen and Vajpeyi, 2022). It is important to recognise that migration, if properly managed, can result in social, cultural and wider economic benefits. Reducing future risks of forced migration and displacement due to climate change is possible through cooperative, international efforts to enhance institutional adaptive capacity and sustainable development (IPCC, 2022).

Halleux (2017) noted that the tourism industry is particularly vulnerable to climate impacts, as the length and quality of the tourist season are highly dependent on weather patterns. While the natural environment plays a crucial role in attracting visitors and enhancing their experience, tourism can also have negative environmental effects, such as pollution, excessive water consumption and damage to land and infrastructure. Kelly and Stack (2009) suggested that rising temperatures in southern Europe may lead to an increase in tourism in northern European countries, including Ireland, by making it a more appealing holiday destination. Furthermore, anticipated temperature increases may lead to an extension of the Irish tourist season, with April and September/October becoming increasingly popular months for travel (Desmond *et al*., 2017). The establishment of Tourism Ireland, which promotes the island as a unified holiday destination, as an all-island body was a positive outcome of the Good Friday Agreement.

Climate change could lead to an increase in vector-borne diseases in Ireland, which can affect humans, domesticated animals and wildlife. According to Climate Northern Ireland (2021), the warming climate in parts of Europe may result in the introduction of new infectious diseases to Ireland. This increase may be due to the increased prevalence of insects, such as mosquitoes, midges and ticks, that transmit vector-borne diseases. A warmer and wetter climate could facilitate the transmission of these diseases, which are usually spread through human activity such as international travel and trade. Furthermore, the importation of contaminated food products and infected animals may also pose a potential risk to human health, despite restrictions and protocols in place (Challinor and Benton, 2021). The CCRA3 Technical Report suggests that climate change, land use change, land degradation and human–wildlife interactions may contribute to the emergence of new diseases (Challinor and Benton, 2022). Altizer *et al*. (2013) also found that these factors, when occurring together, can disturb ecological communities and create more chances for pathogens to interact with different species.

3.4.1 Mechanisms for policy and adaptation

The Department of Health's sectoral adaptation plan for health (DOH, 2019) recommends health impact assessments across sectors, to be carried out in accordance with the Health in All Policies World Health Organization guidelines (WHO, 2015). The plan also refers to the impact on Ireland of heatwaves, pests, diseases and flood events and to international transboundary health risks associated with climate change impacts**.** Risks listed include nutritional deficiencies, acute respiratory infections, diseases attributed to overcrowding, such as measles and meningitis, and foodborne and waterborne diseases. It suggests that extensive screening and immunisation programmes should be introduced, and highlights the important implications of such risks for workforce planning, capacity and training, and the anticipated shifting epidemiology in relation to infectious illnesses. In addition, while the plan recognises the cross-sectoral nature of health impacts, it does not address cross-border impacts on the island of Ireland.

The Department of Tourism, Culture, Arts, Gaeltacht, Sport and Media oversees and supports the tourism and cultural sectors in Ireland, while the Department for the Economy holds this responsibility in Northern Ireland. Tourism Ireland is an all-island tourism marketing company established following the Good Friday Agreement by the then Bord Fáilte and the Northern Ireland Tourist Board. Tourism Ireland is under the authority of the NSMC, with funding provided by Ireland's Department of Tourism, Culture, Arts, Gaeltacht, Sport and Media and Northern Ireland's Department for the Economy. Ireland's Built and Archaeological Heritage Climate Change Sectoral Adaptation Plan discusses the impacts of coastal erosion, coastal and inland flooding, storm damage and microbiological growth on heritage buildings and structures. However, while it references impacts across sectors, it does not refer to cross-border impacts.

3.4.2 Opportunities and challenges

Effectively managing and assisting migrants and/or refugees will require better domestic policy, international cooperation and collaboration at the EU level (Berninger *et al*., 2022). Therefore, improved and coordinated policies and strategies, along with efforts to tackle the root causes of forced migration, will be necessary to manage the potential impacts of the forced displacement of people due to climate change. The asylum process in Ireland may also need to include a new category for people who are migrating as a result of climate change (Loughlin, 2023). Migration can also create challenges related to the integration of refugees and asylum seekers into host communities. It can also exacerbate social, economic and political tensions in the host country (Foresight UK, 2011). Solving such issues in a just way will need more and better collaboration at national and local levels.

Kelly and Stack (2009) argued that Ireland's lush green landscapes, which have long been a major draw for tourists, are at risk because of changes in temperature and precipitation patterns. The natural and cultural assets of Ireland, which are already delicate, will be under increased pressure because of the larger numbers of visitors. Coastal erosion and flooding during storm events will also increase as sea levels rise, endangering coastal attractions, submerging beaches and amenities, and negatively impacting tourism (Halleux, 2017). To ensure the preservation of natural and cultural heritage assets in the face of climate change risks, it is essential to implement policies that consider their potential impact on tourism. However, increased tourist numbers can also create employment opportunities in service industries such as hospitality and environmental protection (Kelly and Stack, 2009). A collaborative approach between government departments, agencies, local authorities and community groups in Northern Ireland and Ireland will be necessary to effectively manage changes across the island, particularly in relation to coastal erosion and inland flooding.

Climate change can contribute to the emergence of infectious diseases in various parts of the world, which can then spread to Ireland through the movement of people and goods. As a result, cooperation at both the international and cross-border levels is essential to prevent and mitigate the risks associated with new infectious diseases. The COVID-19 pandemic is a prime example of a transboundary risk that has transcended various sectors, resulting in systemic risks that extend beyond the healthcare system.

3.5 The Psychological Risk Pathway

In the context of the island of Ireland, the psychological pathway is likely to encompass transboundary risks related to the impact of climate change on

mental health and well-being and to the perceived understanding of climate change as a result of various media communication channels. Increasing awareness of climate change and its potential impacts has led to rising concerns and fears among many individuals. Studies have shown that children are particularly susceptible to worry and distress following climate change events (Hickman *et al*., 2021). Albrecht (2011) coined the term "psychoterratic effects" to describe the psychological impacts of climate change on individuals. One specific manifestation of these impacts is eco-anxiety, which refers to the feelings of worry, anxiety and distress related to the threat of climate change events (Albrecht, 2011; Boluda-Verdu *et al*., 2022). Clayton (2020) highlights that the psychological impacts of climate change on mental health have become more prevalent in recent years. Schwartz *et al*. (2022) described climate change anxiety as the negative cognitive, emotional and behavioural responses to climate change. Other terms used to describe the psychological consequences of climate change include "solastalgia", which describes feelings of sadness and grief due to loss of place, and "eco-paralysis", which refers to an inability to respond to the climate crisis (ECHO, 2022).

Extreme climate events can have detrimental effects on people's mental health, particularly those who have directly experienced the impacts of severe storms, flooding and wildfires (Clayton, 2020; ECHO, 2022). Research has shown that such events can lead to anxiety, depression, post-traumatic stress disorder, substance abuse, sleep disorders and violent behaviour, with children often experiencing stronger effects (Bartlett, 2008). In Ireland, such impacts may be evident in relation to coastal erosion, storm events, flooding and droughts, among others. These events can disrupt people's lives, resulting in loss of place identity and attachment, particularly for those who have experienced damage to their homes or who have been forced to leave their homes (Clayton, 2020). Climate-related events can also negatively affect people's sense of community and belonging, as well as their well-being, through the destruction of natural environments and human infrastructure (ECHO, 2022). People may also experience anxiety associated with uncertainty about the future and grieve the loss of valued places and things, for example solastalgia caused by coastal erosion in Ireland (Phillips and Murphy, 2021; Phillips *et al*., 2022).

3.5.1 Mechanisms for policy and adaptation

Awareness of and the number of studies relating to the psychological impacts of climate change are increasing. At the national level, the Departments of Health in both Northern Ireland and Ireland oversee various competent authorities responsible for public health, including mental health. Ireland's NAF briefly acknowledges the significant climate-related health and well-being impacts resulting from loss and displacement due to flooding and waterborne infectious diseases (DCCAE, 2018). The *Health: Climate Change Sectoral Adaptation Plan 2019–2024* (DOH, 2019) acknowledges that, while attributing specific mental health conditions to climate change is challenging, the psychological effects are being increasingly recognised. While the plan acknowledges the transnational and cross-sectoral nature of health impacts, it does not address cross-border impacts on the island of Ireland.

3.5.2 Opportunities and challenges

Ensuring the effective communication of climate change information is critical for promoting adaptation to the impacts of climate change. However, it is important to recognise that the way in which climate change messaging is conveyed can lead to greater polarisation among individuals who hold differing views (Ma *et al*., 2019). Such communication is particularly relevant in many sectors for the island of Ireland. It is essential that climate change data are accurately and clearly disseminated, to ensure that they are reliable and understood. Failure to do this may result in resistance to policy implementation, which could undermine the intended outcomes. Therefore, adequate resources should be provided for and careful consideration given to enabling the effective communication of climate change information.

In recent years, there has been a notable rise in lobbying and activism by individuals and communities who are taking an active role in combating climate change (Fisher and Nasrin, 2021). Participating in climate activism has been shown to provide social support and a sense of empowerment, which can improve mental health outcomes (Schwartz *et al*., 2022). However, engaging in climate activism can also lead to distress due to negative outcomes and the substantial effort that may be required (Schwartz *et al*., 2022). Therefore, it is important to ensure that individuals and communities have access to

appropriate support, resources and training to manage any psychological impacts that may arise.

Studies such as that by Philips *et al*. (2022) underline the significant contribution that public engagement and consultation at the local level can make to informing adaptation planning in relation to loss of place and damage to infrastructure. In Ireland, residents of coastal areas prone to erosion and areas at risk of flooding should be provided with opportunities to co-design adaptation interventions and engage in decision-making processes as a response to loss of place and infrastructure. Co-production of knowledge and solutions in relation to climate change have been shown to result in better and more sustainable outcomes for those affected (Bolger *et al*., 2021), with better health and well-being outcomes (Quinn *et al*., 2023).

3.6 The Geopolitical Risk Pathway

The economies of Ireland and Northern Ireland are highly open and dependent on links with other countries for trade, and therefore face significant threats from geopolitical risks associated with climate change.

The consequences of extreme weather events such as drought, food shortages and land degradation will result in the loss of livelihoods, lower economic productivity and increased poverty in different regions of the world, with negative consequences for international security (Climate Northern Ireland, 2021). These challenges will influence how countries interact with each other, with significant impacts on international security and stability, particularly in developing countries that are more vulnerable to climate change (IPCC, 2018). The coming decades are also likely to see a growing demand for foreign aid, overseas development assistance and cooperation at the international level (IPCC, 2018).

The geopolitics of climate change is shifting too. Changes in the designations of developed and developing countries, the expansion of key negotiation groupings, such as the BRIC (Brazil, Russia, India and China) bloc, and new loss and damage agreements progressing as part of United Nations Framework Convention on Climate Change negotiations are changing the geopolitical landscape on climate change. Economic interests, loss and damage, international relations and national security could be threatened by failures in international law and governance, making it more difficult to achieve foreign policy objectives of supporting human rights (Climate Northern Ireland, 2021).

3.6.1 Mechanisms for policy and adaptation

Ireland's NAF highlights the country's role in promoting climate resilience in developing nations (DCCAE, 2018). Although the NAF and Climate Action Plan 2023 do not explicitly address international geopolitical risks, reports by the Department of Foreign Affairs and Trade (DFAT) and Irish Aid acknowledge concerns about Ireland's security and potential migration flows (DFAT, 2015; Irish Aid, 2019). DFAT, through Irish Aid, is responsible for most of Ireland's international development initiatives and incorporates climate change and climate risk management into its community-based adaptation and development programmes and planning (DCCAE, 2018). In recent years, Ireland has been actively contributing to climate finance in developing countries to support their adaptation goals (DFAT, 2015; Irish Aid, 2019). Both *The Global Island: Ireland's Foreign Policy for a Changing World* and *A Better World: Ireland's Policy for International Development* prioritise climate action in developing countries, particularly in the least developed countries (DFAT, 2015; Irish Aid, 2019).

DFAT's 2015 Global Island report recognises existing conflicts, terrorism, organised crime and cyberattacks as global security threats. While it highlights the benefits of globalisation, it also acknowledges its negative impacts, such as public health concerns related to disease transmission from abroad. According to Irish Aid (2019), climate change poses a threat to the progress made in combating extreme poverty by slowing economic development, worsening gender inequality and increasing food insecurity. Furthermore, marginalisation, human rights violations and exploitation can also exacerbate conflict, leading to the forced migration of people in search of better opportunities, both within and across borders.

3.6.2 Opportunities and challenges

Geopolitical risks are interconnected and can interact with other transboundary pathways, such as changes in population movement, biophysical risks and trade.

In vulnerable nations and regions, climate change has been shown to increase the stress on available resources and government structures, thereby amplifying other risks (Challinor and Benton, 2021). This complexity makes it challenging to assess and quantify geopolitical risks and their impacts. Ireland has a long-standing tradition of supporting social and economic development through foreign aid and international cooperation. The country allocates funds to partner countries, international organisations such as the United Nations, the International Red Cross Movement, and Irish national and international non-governmental organisations (Irish Aid, 2019; DFA, 2023). However, as noted by Irish Aid (2019), Ireland's capacity to drive change may be limited by emerging and evolving circumstances. Increasing geopolitical impacts are likely to affect relief work and international aid programmes in which Ireland plays a significant role. Consequently, Ireland may experience a rise in demand for funding for development and emergency aid, as well as for climate change adaptation, from developing countries. These challenges will require Ireland to adapt and strengthen its foreign aid policies and strategies to continue to effectively support social and economic development in developing countries.

A report by the Commission of Defence Forces (CoDF, 2022) underscores the importance of resources and policies to safeguard Ireland's national security in the face of persistent threats, such as violent conflict, organised crime, terrorism and migration, that originate outside the EU. These threats also pose challenges for EU cohesion and solidarity. The report notes that such threats will most likely lead to a growing demand for Ireland's military defence forces to play a more prominent role in supporting peace efforts, managing crises and providing humanitarian relief operations.

Improving food security in a climate-threatened world may require higher prices and the exploration of alternative sources of food through substitution and diversification. However, climate impacts may make it challenging to find such alternatives, leading to heightened geopolitical tensions as nations prioritise their own climate vulnerability by pursuing greater self-sufficiency. Such responses could impede global efforts towards building resilience and adaptation. These dynamics have been highlighted in various studies, including a report by the World Economic Forum (WEF, 2023), which warns of the risk of a rise in protectionism and trade barriers in response to climate change impacts. Such responses may harm global trade and cooperation, ultimately hindering efforts to build resilience to climate-related risks. It is therefore essential to address these tensions and promote more comprehensive approaches that prioritise global cooperation and coordination towards building resilience and adaptation.

As highlighted by Challinor and Benton (2021), the interdependent nature of the UK and Irish economies presents a significant risk to climate resilience. Brexit-related challenges could make collaboration between the jurisdictions of the island of Ireland more difficult. The different legislative environments will present challenges for policymakers and decision-makers. In addition, shared water bodies and infrastructure, such as the electricity grid, may be subject to increasing pressure and vulnerability.

3.7 The Finance Risk Pathway

Climate change poses significant risks to the island of Ireland's financial and business sectors, particularly through the transmission of risks and impacts via the finance pathway. The Financial Stability Board (FSB, 2020) noted that extreme climate events such as floods, droughts and heatwaves can cause significant financial exposure for insurance companies, banks, investment firms and individual investors operating on a global scale. These risks can take different forms, including physical, transition and liability risks. Physical risks result from the damage caused by climate events to property and infrastructure, while transition risks arise from the transition to a low-carbon economy, which can impact the value of assets and investments. Liability risks stem from the legal and financial liabilities associated with climate change, including lawsuits and compensation claims. Moreover, as vulnerable countries and regions face increasingly severe climate events, assets in these countries may become non-viable, posing a significant risk to international finance (Climate Northern Ireland, 2021). Furthermore, predicting the impact of physical risks on financial assets is challenging because of the uncertain nature of climate risks (FSB, 2020), while recent research by Trust *et al*. (2023) highlights that climate risks in the financial services sector may be significantly underestimated.

At the domestic level, the impacts of climate events on finance, investments, insurance cover and the availability of capital for businesses should not be underestimated. Climate events may lead to a reduction in the value of assets and investments, an increase in credit risks and a rise in the cost of capital, causing a decline in the availability and affordability of insurance. The CCRA3 summary report for Northern Ireland highlights this as a "medium risk", which may escalate to a "high risk" (Climate Northern Ireland, 2021). Flooding represents the most significant risk and has consequences for insurance, investments and mortgages. Furthermore, the sudden damage and disruption to the infrastructure of a business can result in an immediate financial setback, requiring investment and access to capital. Such risks require consideration at policy level for shared river basins and catchments that are exposed to flooding risks, as well as related infrastructure in both Northern Ireland and Ireland.

3.7.1 Mechanisms for policy and adaptation

In Ireland, the Department of Finance is responsible for achieving the government's economic, fiscal and financial policy objectives. The Department of Enterprise, Trade and Employment collaborates with key stakeholders to address business or sectoral issues in all areas of enterprise activity. In Northern Ireland, the Department for the Economy is responsible for similar work. Furthermore, collaboration in these matters across the island of Ireland is facilitated through cross-border organisations such as InterTradeIreland and Tourism Ireland.

3.7.2 Opportunities and challenges

Risks through the finance pathway may negatively impact Irish physical and financial assets abroad. Extreme climate events present physical and liability risks for the global financial system, which could lead to market and credit risks. Such risks could cause assets such as real estate, stocks and bonds to lose value, resulting in losses for banks, investment companies and private individuals (FSB, 2020). In addition, climate change-related risks could trigger a financial crisis by combining several risks, including substantial reductions in the value of traditional energy companies due to disinvestment in fossil fuels, and further rises in insurance costs resulting from underwriting risks related to losses and damages caused by extreme climate events such as droughts and floods (FSB, 2020). Irish investments are vulnerable to such risks, particularly those that relate to the physical risks associated with foreign property and assets owned by Irish companies and individuals.

Volz *et al*. (2021) noted that shifting trade patterns can have a significant impact on financial trade balances and international financial flows. The reduction in fossil fuel imports and exports, and related products, along with a surge in renewable energy trade, could bring about substantial changes in the global commerce landscape, potentially leading to significant consequences for global financial systems. In this context, the implementation of the Irish government's various plans, such as the National Retrofit Plan and the plan to deploy renewable energy technologies to Irish homes and businesses, will be crucial. Therefore, adaptation policies to improve awareness, knowledge and access to relevant grant schemes to facilitate this transition should be prioritised. The realisation of a climate-resilient Ireland and successful adaptation to climate change would offer significant potential for investment in domestic assets in both Northern Ireland and Ireland. However, to realise this potential, it is important to have policy frameworks in place that promote sustained private investment, particularly for initiatives that facilitate a transition to a low-carbon economy.

Private sector involvement is essential in managing and reducing TCRs, particularly in finance and business. Governments face challenges in regulating and coordinating adaptation policies for these risks, and businesses, investors and consumers are also expected to play a critical role. The corporate community on the island of Ireland recognises the importance of collaboration on climate change, and effective cross-border working relationships with the business communities in both jurisdictions are necessary to achieve climate objectives and capitalise on economic potential (IBEC, 2019).

3.8 The Infrastructure Risk Pathway

The impacts of climate change have consequences for energy supplies; the movement of people, goods and services; communications systems; and water storage and supply. Ensuring the security and reliability of energy supply is a crucial concern. As the electricity supply on the island of Ireland is managed through

a shared all-island energy network, it is important to consider policies that address the management of such risks both in the border areas and for the island as a whole. Collaboration via the development of the North–South interconnector will link electricity transmission networks across the island and more than double power transfer capacity between Northern Ireland and Ireland. Critical infrastructure in Ireland, such as power stations, refineries and storage facilities, is predominantly located in coastal regions and in close proximity to rivers for ease of access. However, these locations are vulnerable to flooding due to extreme storm events, sea level rise and higher waves. Furthermore, higher precipitation levels and temperatures resulting from climate change will have significant impacts on the functioning of infrastructure (Desmond *et al*., 2017). This is particularly important for Irish ports, which are a critical part of the infrastructure at the heart of many of the transboundary risk pathways discussed in this chapter.

Efficient transport networks are essential for Ireland's economy, which relies heavily on the movement of goods and services. According to Ryan *et al*. (2021), climate risks to Irish transport infrastructure include fluvial flooding and coastal flooding and erosion due to sea level rise, increased precipitation and extreme storm events, which may result in blocked or damaged transport networks. Bridge scouring (erosion of sediment from around bridge foundations and abutments or piers) may also cause bridge failure, leading to significant transport network disruption. Furthermore, as the transport sector moves towards electrification, ICT and energy infrastructure failures will also pose a risk. These risks will need to be considered in policy in the border counties, particularly for river basins and water bodies shared between Northern Ireland and Ireland. In Ireland, local authority climate action plans provide an opportunity to increase cross-border collaboration on these and other issues.

Climate impacts affecting transport infrastructure outside Ireland, including roads, railways, bridges, ports and airports, can have cascading effects, such as supply disruptions in Ireland. The expected increase in future climate-related extreme events is likely to negatively impact key infrastructure globally, and infrastructure is also at risk from more gradual climate changes such as sea level rise (IPCC, 2022). Coastal infrastructure impacts are particularly concerning for international transport and trade, as maritime transport is a critical element of the international supply chain, with over 80% of the volume of globally traded goods transported through seaports (EEA, 2017; UNCTAD, 2022). This would have implications for businesses in both Ireland and Northern Ireland, impacting the supply of food, energy, medicine and other essential items. The higher occurrence of extreme weather events is expected to have an impact on ICT networks, with infrastructure being susceptible to storm or heat damage. As these systems are globally interconnected, any disruptions can have a ripple effect, leading to considerable disturbance in the operation of crucial services in Irish society (Climate Ireland, 2023).

3.8.1 Mechanisms for policy and adaptation

In Ireland, the government departments responsible for critical infrastructure are the Department of Transport, the Department of Environment, Climate and Communications, the Office of Public Works (OPW) and the Department of Housing, Local Government and Heritage. In Northern Ireland, the relevant departments are the Department of Infrastructure, the Department of the Economy and DAERA.

Ireland's *Transport: Climate Change Sectoral Adaptation Plan* (DTTS, 2019) highlights the significance of cross-border transport networks in facilitating travel, public transport services and trade activity between Northern Ireland, the border regions and the rest of the island. Thus, it is crucial to ensure the resilience of networks such as the Dublin to Belfast road and rail corridors, to maintain high levels of economic and social activity. The transport sectoral adaptation plan (DTTS, 2019) also acknowledges the role of BIC in addressing mutual issues of transboundary interest, including environmental concerns. The plan highlights the ministerial-level meeting of the British-Irish Council Environment Work Sector, which included a focus on climate adaptation. Members recognised that common challenges present substantial opportunities for cooperation in terms of exchanging information and best practices across different administrations, and emphasised the need to explore ways to improve coordinated and co-funded research mechanisms, with the Taoiseach's SII highlighted as a potential forum to advance cross-border risks.

Ireland's sectoral adaptation plan for electricity and gas networks highlights the interdependency of sectors and the potential for cascading effects due to climate drivers, but does not explicitly detail the implications of cross-border impacts (DCCAE, 2019). The flood risk management sectoral adaptation plan of the OPW recognises the impact of cascading transboundary climate impacts in flood risk management, but cross-border considerations are not specifically referenced (OPW, 2019). The water quality and water services infrastructure adaptation plan of the Department of Housing, Planning and Local Government also alludes to the importance of collaboration at the cross-sectoral level, but does not specifically address cross-border impacts (DHPLG, 2019). The CCRA3 summary report for Northern Ireland (Climate Northern Ireland, 2021) does not explicitly refer to transboundary or cross-border climate impacts in relation to critical infrastructure on the island of Ireland. Nonetheless, it identifies various infrastructure services in Northern Ireland that require attention, such as transport and rail networks, bridges, water resources, energy and digital (ICT) networks, and are also crucial for Ireland and have cross-border implications for the island of Ireland.

3.8.2 Opportunities and challenges

As outlined above, risks to critical infrastructure in Ireland are not limited to domestic factors. Therefore, building resilience in critical infrastructure, as well as ensuring the security of raw materials for its construction and maintenance, is crucial for avoiding disruptions that can have severe impacts on the economy and services. It is essential to acknowledge that Ireland's critical infrastructure represents highly interconnected systems, where impacts on one system can indirectly affect others. Therefore, managing critical infrastructure from a long-term perspective, while considering the cascading effects of TCRs, is crucial for making informed decisions and avoiding maladaptive measures that focus on risks at only the national and regional levels.

Collaborative efforts between the transport sectors in Northern Ireland, the border region and the rest of the island are necessary to ensure the resilience of cross-border transportation networks. These networks, which include the Dublin to Belfast road and rail corridors, play a critical role in facilitating local travel, public transport and significant road freight activity. Disruptions to these networks can have significant social and economic impacts (DTTS, 2019).

The shift towards renewable energy sources will be driven by changes in energy markets and concerns about fossil fuel supply. At present, Ireland is highly dependent on fossil fuel supply. However, Ireland's strategic location and abundant coastline provides significant opportunities for wave energy generation and additional wind energy generation, which are likely to become increasingly exploited in the future. However, as the risk of extreme weather events such as storms and sea level rise increases, offshore renewable energy infrastructure may be at risk of damage. Ongoing improvements to policy and infrastructure will be necessary to manage transboundary risks for the energy sector and sustain Ireland's energy needs in the coming decades.

3.9 Private Sector

Risks related to international supply chains and foreign direct investment, which have cross-border impacts, may have significant implications for the private sector. Such risks include price increases, supply chain disruptions and financial crises. Governments face challenges in regulating and coordinating adaptation policies for these risks, due in particular to the lack of available data and transparency in privately owned and managed risks. Adaptation Without Borders (2022a) also stressed the need for the private sector to be involved in addressing TCRs alongside regional policymaking organisations and local authorities, particularly with respect to trade and finance. Businesses, investors and consumers are expected to play a critical role in managing and reducing TCRs. However, this will require encapsulating these risks into the processes and operations of businesses on a global scale. In Ireland, the corporate community recognises the importance of collaboration on climate change. The Irish Business and Employers' Confederation (IBEC, 2019) has called for an innovative and comprehensive strategy to achieve climate objectives while capitalising on the economic potential of the island of Ireland. To achieve these aims, effective cross-border working relationships with the business communities in both jurisdictions are necessary.

4 Stakeholder Perspectives: What Makes Effective Transboundary Climate Risk Policy?

4.1 Introduction

To examine issues surrounding TCR policy development and implementation for the island of Ireland, a virtual workshop was held, comprising representatives from sectors from the island of Ireland and England. The workshop took place online over a half-day and brought together key stakeholders to discuss and identify effective TCR policy and barriers to developing such policy for the island of Ireland. Three themes were considered by participants in breakout sessions. First, participants explored what effective transboundary risk policy would look like. Second, they examined and discussed where responsibility for such policy development lies. Third, the opportunities that exist for collaboration both on the island of Ireland and internationally were investigated. Breakout session 2 explored the barriers to TCR policy for the island of Ireland. Barriers to developing effective TCR policy were identified and suggestions and thoughts on how they may be dealt with were also gathered. Each breakout session concluded with a feedback summary of the main points gathered for each of the questions asked. These points were presented by the workshop facilitators to the other groups. A discussion was held after the breakout sessions to put forward any other suggestions or comments. An overall synthesis of the findings was then generated and presented to the plenary group. This comprised a high-level summary of insights from the breakout sessions and the final discussion. In the following sections, we present the key issues for effective transboundary risk policy as highlighted by participants.

4.2 Leveraging Existing Institutions

Participants concluded that, for transboundary policy to be effective, existing cross-border government institutions such as the NSMC, BIC and the SII need to be involved in policy development for TCRs. As these institutions engage in formal and informal dialogue at the government level both between Ireland and Northern Ireland (NSMC) and between the island of Ireland and the UK (BIC), it is important that transboundary risks are discussed and considered as part of their collaboration on climate policy. Ireland is in the advantageous position of having cross-border institutions in place, and these should be leveraged accordingly. The development of shared adaptation goals in relation to transboundary risks and deciding and agreeing on them are tasks that could be facilitated and supported by the SII, BIC and the NSMC. It was also acknowledged that there are many existing regulatory and legislative frameworks within the EU based on international best practice and guidance (see Chapter 2). Participants suggested that these could be combined with other risk/contingency planning, which is broader than climate risk planning, to make use of existing mechanisms and expertise.

4.3 Securing Political Will

For transboundary risk policy to be effective, political will must exist for addressing risks, establishing appropriate adaptation policies and implementing them. Contemplating and addressing local-scale climate impacts and using traditional adaptation policy and risk assessments can be said to be less complex and challenging. However, the political will to examine and tackle the international dimensions of climate risks is crucial for future societal climate resilience. Participants expressed concern about the ongoing absence of the Northern Ireland Executive, and suggested that the onus is now on Ireland to drive this agenda at the national and local levels.

4.4 Addressing Trade Concerns

Participants also raised concerns about how TCRs might impact trade and trade agreements, and discussed the importance of trying to support them. Assessing transboundary risks may reveal over-reliance on particular countries or regions for trade and advocate for more diverse trading partnerships. Cross-border trade was also noted as being a particularly important concern for the island of Ireland given the implications of Brexit for international trade.

4.5 Knowledge Sharing

Gaining a better understanding of TCRs and the possibilities for the cascading of such risks across borders was deemed essential for ensuring that high-quality evidence to inform climate policies is being communicated to policymakers. Participants noted that communication and the sharing of knowledge are important not just internationally but also within jurisdictions for identifying priorities and communicating actions.

4.6 Collaboration and Coordination

Participants agreed that collaboration and the coordination of efforts across scales and the need for coherence across jurisdictions and sectors are crucial elements of effective transboundary climate policy. Local authorities were identified as a potentially good level for collaboration, with Derry-Strabane and Donegal highlighted as good examples of leadership in the area of climate policy. Early collaboration was seen as important for preventing effects from becoming prevalent and resulting in more difficult issues to overcome. Collaboration and coordinated efforts will prevent a mismatch between evidence for policymakers and research, and strengthen links between both. Identifying opportunities for joint working will also result in the avoidance of duplication. It was also noted that such efforts would help to identify key differences in policy or legislation. Building capacity within institutions for instigating collaborative efforts was also suggested as a way of ensuring effective transboundary climate policy.

4.7 Funding, Resources and Research

Participants raised points relating to the importance of adequate funding, resources and research for TCRs and associated policy development.

Participants identified the need for policy development to be supported with recurrent and sufficient funding and research. Participants also acknowledged the importance of iterating existing studies to understand emerging risks and incorporating the results into adaptation planning and policy, and discussed how such efforts will require ongoing commitment and investment. Having sufficient human resources within institutions and organisations was also identified as being of importance, with new expert roles across sectors being suggested for specifically implementing transboundary climate change policies. Having commitment and investment from all stakeholders was also viewed as being important for effective transboundary climate policy.

4.8 Ensuring Just Outcomes

Participants emphasised the importance of ensuring a just transition as part of transboundary climate adaptation policy implementation. Ensuring that adaptation is just and equitable will require examining how justice might be achieved between communities or between countries, particularly when there are differences in vulnerability, capability and power. Policies need to be coherent and responsive to the needs of communities. As an example, it was suggested that, in relation to health, policies must be built on the socio-economic and environmental determinants of health, and focus on reducing health inequalities.

4.9 Monitoring Risks

The monitoring of risks was identified as an area that must be prioritised for effective transboundary climate policy. Participants proposed that mechanisms for measuring and monitoring the impacts of transboundary risks should be in place, with clearly identified risk owners. A forum for developing responses to emergencies across countries was also suggested. Likewise, it was suggested that indicators and monitoring should be shared and understood, with strong governance structures put in place. These should ensure consistency in risk assessments and risk scoring.

4.10 Assigning Responsibility

Research at the international level has demonstrated that responsibility for TCR policy is complex in nature and will be equally as complicated for the island of Ireland. While it can depend on the type of risk, it was acknowledged by participants that ownership of risks and responsibility for transboundary policy development should sit in multiple places and will traverse both private and public sectors. However, participants overwhelmingly recognised that

transboundary climate policy requires a whole-of-government approach that is led from the top down and then coordinated across sectors. Participants therefore recommended that such a collaborative approach needs to be both horizontal (across sectors) and vertical (linking EU, national, sectoral and local levels).

4.11 Leveraging Opportunities for Collaboration

Participants noted the existence of many initiatives and partnerships involving the island of Ireland that relate to climate change. These include the SII, Climate Northern Ireland and Sustainable Northern Ireland, Climate Ireland, the AICBRN, the North-West Strategic Growth Partnership, the International Centre for Local and Regional Development and groups such as the BIC adaptation subgroup, the EU Working Group on Adaptation and the International Climate Councils Network (both Ireland and the UK are members), which facilitate adaptation work at the international level for Ireland. It was suggested that such networks can be developed and built on to include TCRs. For Ireland, it was suggested that TCRs should be built into the new NAF and that efficient links should be established with the EU. The All-Island Research Funding Partnerships were also suggested as a means for facilitating funding collaboration on TCR research projects across the island of Ireland.

Producing and sharing data relating to local climate change impacts across jurisdictions was identified as an important element of decision-making relating to transboundary climate policy development. The sourcing of and access to such data have also been identified as issues on the international scale. Participants pointed out that there are possibilities for developing information repositories and, particularly, new climate services and portals. It was also suggested that platforms such as Climate Ireland and Climate Northern Ireland could inform an understanding of TCRs and co-develop and share methodologies relating to transboundary assessment and policy recommendations. All-island risk assessments would also enable comparisons to be made between jurisdictions and prevent duplication of assessments and resource wastage.

4.12 Concluding Messages and Recommendations

- TCRs are underassessed and policies for addressing them are underdeveloped both in Ireland and internationally. The literature shows that the assessment of TCRs often reveals unknown or underestimated risks, which can equal or exceed national-based risks from climate change. This report recommends the adoption of seven pathways for assessing and planning for TCRs (see Chapter 3): trade, biophysical, people, geopolitical, psychological, finance and infrastructure.
- As a small, open economy and part of a shared island, Ireland is particularly susceptible to TCRs. Indeed, the TCR Index ranks Ireland as 68th in the top 70 countries globally in terms of vulnerability to TCRs and among the most exposed globally to impacts on global trade. However, vulnerabilities exist across all seven pathways considered.
- TCRs are poorly understood, and interdisciplinary skills are needed to gain a better understanding of pathways. Programmatic research across each of the seven pathways identified is needed. The All-Island Research Funding Partnerships could be utilised for funding collaboration on cross-border and TCR research projects.
- For TCR policy to be effective, it will be important that existing cross-border government institutions such as the NSMC, BIC and the SII are involved in policy development on an island-of-Ireland scale. Ireland is in the advantageous position of having cross-border institutions in place, and these should be leveraged accordingly.
- Given its exposure, the inclusion of the private sector in identifying and responding to TCRs is crucial, especially for the trade and finance risk pathways. Governments face challenges in regulating and coordinating adaptation policies for these risk pathways, due in particular to the lack of available data and transparency in privately owned and managed risks.
- An international collaborative and participatory approach involving partnerships between different countries and jurisdictions will advance TCR adaptation expertise and awareness relating to TCRs. Countries will not be able to tackle TCRs alone.

- The ownership of risks and responsibility for transboundary policy development should sit in multiple places and traverse both private and public sectors. Our participants overwhelmingly recognised that transboundary climate policy requires a whole-of-government approach that is led from the top down and then coordinated across sectors. Participants therefore recommended that such a collaborative approach needs to be both horizontal (across sectors) and vertical (linking EU, national, sectoral and local levels).
- On the cross-border scale, local authorities were identified as a potentially good level for collaboration, with Derry-Strabane and Donegal highlighted as good examples of leadership in the area of transboundary climate policy.
- TCRs should be built into the new NAF for Ireland and efficient links should be established with the EU. In addition, a national risk assessment should include assessment of TCRs, while user-friendly guidance and evaluation methods (frameworks, methodologies and metrics) need to be developed to aid the assessment and prioritisation of TCRs in the next generation of sectoral adaptation plans.

References

Adams, K., Harris, K., Klein, R.J.T., Lager, F. and Benzie, M. (2020). *Climate-resilient Trade and Production: the Transboundary Effects of Climate Change and Their Implications for EU Member States.* Adaptation Without Borders Policy Brief. Stockholm Environment Institute, Overseas Development Institute and International Institute for Sustainable Development and International Relations. Available online: https://www.sei.org/publications/climate-resilient-trade-production-transboundary-eu/ (accessed 8 July 2021).

Adaptation Without Borders (2022a). *Transboundary Climate Risks: An Overview*. Available online: https://adaptationwithoutborders.org/wp-content/uploads/2024/01/transboundary_climate_risks_web-2.pdf (accessed 2 October 2022).

Adaptation Without Borders (2022b). *Adaptation Without Borders: An Overview*. Available online: https://adaptationwithoutborders.org/wp-content/uploads/2024/01/adaptation_without_borders_conceptnote_extended_july2021-1.pdf (accessed 7 November 2022).

Albrecht, G. (2011). Chronic environmental change: emerging “psychoterratic” syndromes. In: Wiessbecker, I. (ed.), *Climate Change and Human Well-being*, Springer, New York, NY, pp. 43–56.

Altizer, S., Ostfeld, R.S., Johnson, P.T., Kutz, S. and Harvell, C.D. (2013). Climate change and infectious diseases: from evidence to a predictive framework. *Science* 341(6145): 514–519.

Bartlett, S. (2008). Climate change and urban children: impacts and implications for adaptation in low- and middle-income countries. *Environment and Urbanization* 20(2): 501–519.

Benzie, M. and Harris, K. (2020). *Transboundary Climate Risk and Adaptation.* Science For Adaptation Policy Brief No. 2. The World Adaptation Science Programme (WASP) Secretariat, United Nations Environment Programme, Nairobi.

Benzie, M., Hedlund, J. and Carlsen, H. (2016). *Introducing the Transnational Climate Impacts Index: Indicators of Country-level Exposure – Methodology Report*. Stockholm Environment Institute, Sweden.

Benzie, M., Carter, T.R., Carlsen, H. and Taylor, R. (2019). Cross-border climate change impacts: implications for the European Union. *Regional Environmental Change* 19: 763–776.

Berninger, K., Lager, F., Botnen Holm, T., Tynkkynen, O., Klein, R.J., Aall, C., Dristig, A., Määttä, H. and Perrels, A. (2022). *Nordic Perspectives on Transboundary Climate Risk: Current Knowledge and Pathways for Action*. Nordic Council of Ministers, Copenhagen. Available online: https://www.sei.org/publications/nordic-perspectives-transboundary-climate-risk/ (accessed 3 May 2023).

Bolger, P., Brereton, P., Grant, O. and Torney, D. (2021). *Better Together: Knowledge Co-production for a Sustainable Society*. Royal Irish Academy, Dublin, Ireland. Available online: https://cora.ucc.ie/server/api/core/bitstreams/499995b2-fd36-43a1-879a-b8d5bc04d218/content (accessed 25 January 2024).

Boluda-Verdu, I., Senent-Valero, M., Casas-Escolano, M., Matijasevich, A. and Pastor-Valero, M. (2022). Fear for the future: eco-anxiety and health implications, a systematic review. *Journal of Environmental Psychology* 84: 101904.

Bord Bia (2022). *Export Performance and Prospects Report 2022–2023*. Available online: https://www.bordbia.ie/globalassets/bordbia.ie/industry/2022---2023-export-performance--prospects-final.pdf (accessed 6 February 2023).

Bosselmann, A.S. and Callesen, G.E. (2020). *Ændringer i drivhusgasudledninger fraarealanvendelse som følge af dansk import af afskovningsfri soja og palmeolie*. Department of Food and Resource Economics, University of Copenhagen, Denmark.

Burke, B., Lewis, L.J., Fitzgerald, N., Frost, T., Austin, G. and Tierney, T.D. (2018). Estimates of waterbird numbers wintering in Ireland, 2011/12–2015/16. *Irish Birds* 11: 1–12.

Cadogan, S. (2018). Mairead McGuinness says fodder crisis is EU-wide. *Irish Examiner*, 23 August 2018. Available online: https://www.irishexaminer.com/farming/arid-30864006.html (accessed 28 August 2023).

Caldara, D. and Iacoviello, M. (2022). Measuring geopolitical risk. *American Economic Review* 112(4):1194–1225.

Carter, T.R., Benzie, M., Campiglio, E., Carlsen, H., Fronzek, S., Hildén, M., Reyer, C.P. and West, C. (2021). A conceptual framework for cross-border impacts of climate change. *Global Environmental Change* 69: 102307.

CASCADES (2022a). Cascading climate risks: towards adaptive and resilient European societies. Available online: https://www.cascades.eu/ (accessed 4 October 2022).

CASCADES (2022b). Methodologies. Available online: https://www.cascades.eu/about/methodologies/ (accessed 5 October 2022).

Cepero, O.P., Desmidt, S., Detges, A., Tondel, F., Van Ackern, P., Foong, A. and Volkholz, J. (2021). *Climate Change, Development and Security in the Central Sahel*. CASCADES. Available online: https://www.cascades.eu/wp-content/uploads/2021/06/Climate-Change-Development-and-Security-in-the-Central-Sahel.pdf (accessed 25 January 2025).

Challinor, A. and Benton, T.G. (2021). Chapter 7: International dimensions. In: Betts, R.A., Haward, A.B. and Pearson, K.V. (eds), *The Third UK Climate Change Risk Assessment Technical Report*. Prepared for the Climate Change Committee, London.

Challinor, A.J., Adger, W.N., Baylis, M., Benton, T., Conway, D., Depledge, D., Geddes, A., McCorriston, S., Stringer, L. and Wellesley, L. (2016). Chapter 7: International dimensions. In: *UK Climate Change Risk Assessment 2017: Evidence Report*. Available online: https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Chapter-7-International-dimensions.pdf (accessed 25 January 2024).

Challinor, A.J., Adger W.N. and Benton, T.G. (2017). Climate risks across borders and scales. *Nature Climate Change* 7: 621–623.

Challinor, A.J., Adger, W.N., Benton, T.G., Conway, D., Joshi, M. and Frame, D. (2018). Transmission of climate risks across sectors and borders. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 376: 2121.

Chatham House (2022). CASCADES climate risks. The Royal Institute of International Affairs. Available online: https://www.chathamhouse.org/about-us/our-departments/environment-and-society-centre/cascades-climate-risks#:~:text=The%20project&text=It%20remains%20unclear%20what%20effect,conflicts%20and%20changing%20security%20threats (accessed 4 October 2022).

Clayton, S. (2020). Climate anxiety: psychological responses to climate change. *Journal of Anxiety Disorders* 74: 102263.

Climate Northern Ireland (2021). *Evidence for the Third UK Climate Change Risk Assessment (CCRA3): Summary for Northern Ireland*. Available online: https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA-Evidence-Report-Northern-Ireland-Summary-Final.pdf (accessed 15 December 2022).

CoDF (Commission on the Defence Forces) (2022). *Report of the Commission on the Defence Forces*. Available online: https://www.military.ie/en/public-information/publications/report-of-the-commission-on-defence-forces/report-of-the-commission-on-defence-forces.pdf (accessed 25 March 2022).

Crowe, O., Boland, H. and Walsh, A. (2012). Irish Wetland Bird Survey: results of waterbird monitoring in Ireland in 2010/11. *Irish Birds* 9(3): 397–410.

CSO (Central Statistics Office) (2019). Ireland's trade in goods 2018. Available online: https://www.cso.ie/en/releasesandpublications/ep/p-ti/irelandstradeingoods2018/introduction/ (accessed 1 February 2024).

DAFM (Department of Agriculture, Food and the Marine) (2019). *Agriculture, Forest and Seafood: Climate Change Sectoral Adaptation Plan*. Available online: https://www.gov.ie/pdf/?file=https://assets.gov.ie/75637/95906844-b6de-42b3-ad32-33bcf7ac8158.pdf#page=null (accessed 8 February 2020).

DAFM (Department of Agriculture, Food and the Marine) (2022). *Annual Review and Outlook for Agriculture, Food and the Marine 2022*. Available online: https://www.gov.ie/en/publication/91e7e-annual-review-and-outlook-for-agriculture-food-and-the-marine-2020/ (accessed 6 February 2023).

DCCAE (Department of Communications, Climate Action and Environment) (2018). *National Adaptation Framework: Planning for a Climate Resilient Ireland*. Available online: https://www.gov.ie/en/publication/fbe331-national-adaptation-framework/ (accessed 26 November 2022).

DCCAE (Department of Communications, Climate Action and Environment) (2019). *Electricity & Gas Networks Sector: Climate Change Adaptation Plan*. Available online: https://www.gov.ie/pdf/?file=https://assets.gov.ie/77095/15ef9327-168a-439e-8ef5-8aaa11934471.pdf#page=null (accessed 25 January 2024).

DCHG (Department of Culture, Heritage and the Gaeltacht) (2017). *National Biodiversity Action Plan 2017–2021*. Department of Culture, Heritage and the Gaeltacht, Dublin.

DCHG (Department of Culture, Heritage and the Gaeltacht) (2019). *Biodiversity: Climate Change Sectoral Adaptation Plan*. Available online: https://www.gov.ie/pdf/?file=https://assets.gov.ie/75638/f9fd4e79-c0ff-4323-8439-b96780631220.pdf#page=null (accessed 8 February 2023).

Deignan, K., O'Hora, A., Delargy, O., Heuston, L. and Morrow, C. (2019). *Climate Change Adaptation: Risks and Opportunities for Irish Businesses*. Environmental Protection Agency, Johnstown Castle, Ireland. Available online: https://www.epa.ie/publications/research/climate-change/Research_Report_402.pdf (accessed 16 December 2022).

DFA (Department of Foreign Affairs) (2023). *Statement of Strategy 2023–2025*. Government of Ireland. Available online: https://www.dfa.ie/media/dfa/aboutus/DFA-Statement-of-Strategy-2023-2025.pdf (accessed 1 February 2024).

DFAT (Department of Foreign Affairs and Trade) (2015). *The Global Island: Ireland's Foreign Policy for a Changing World*. Available online: https://www.dfa.ie/media/dfa/alldfawebsitemedia/ourrolesandpolicies/ourwork/global-island/the-global-island-irelands-foreign-policy.pdf (accessed 29 March 2023).

DHLGH (Department of Housing, Local Government and Heritage) (2018). River Basin Management Plan 2018–2021. Available online: https://www.gov.ie/en/publication/429a79-river-basin-management-plan-2018-2021/ (accessed 6 February 2023).

DHPLG (Department of Housing, Planning and Local Government) (2019). *Water Quality and Water Services Infrastructure: Climate Change Sectoral Adaptation Plan*. Available online: https://www.gov.ie/pdf/?file=https://assets.gov.ie/75644/057df848-7665-4df1-9abf-1a493f1de7f9.pdf#page=null (accessed 6 March 2023).

DOH (Department of Health) (2019). *Health: Climate Change Sectoral Adaptation Plan 2019–2024*. Available online: https://www.gov.ie/pdf/?file=https://assets.gov.ie/75646/9e0dce8a-cebf-496a-aed4-fbe8c285183c.pdf#page=null (accessed 5 March 2023).

DTTS (Department of Transport, Tourism and Sport) (2019). *Transport: Climate Change Sectoral Adaptation Plan*. Available online: https://assets.gov.ie/39222/284b27f3507a411b982d8aff91e1bf49.pdf (accessed 27 March 2023).

EC (European Commission) (2021). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change". COM(2021) 82 final, 24.2.2021, Brussels. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0082&from=EN (accessed 1 June 2022).

ECHO (European Climate and Health Observatory) (2022). *Climate Change Impacts on Mental Health in Europe – An Overview of Evidence*. Available online: https://climate-adapt.eea.europa.eu/en/observatory/evidence/health-effects/mental-health-effects/european_climate_health_observatory_mental-health_evidence_review_2022.pdf (accessed 23 March 2023).

EEA (European Environment Agency) (2017). *Climate Change Impacts and Vulnerability in Europe 2016: An Indicator-based Report.* EEA Report No. 1/2017. Available online: https://climate-adapt.eea.europa.eu/en/metadata/publications/climate-change-impacts-and-vulnerability-in-europe-2016/climate-change-impacts-and-vulnerabilities-2016-thal17001enn.pdf (accessed 27 March 2023).

Environmental Pillar (2022). *Towards a New Agricultural and Food Policy for Ireland – Recommendations for Government*. Available online: https://assets.gov.ie/162850/7eb71aa4-8b17-4913-a011-b73e9dcc6178.pdf (accessed 3 May 2023).

EPA (Environmental Protection Agency) (2017). Tackling invasive species – biosecurity needs to be second nature to us all. Available online: https://www.catchments.ie/tackling-invasive-species-biosecurity-needs-second-nature-us/ (accessed 16 December 2022).

Fisher, D.R. and Nasrin, S. (2021). Climate activism and its effects. *Wiley Interdisciplinary Reviews: Climate Change* 12(1): e683.

Foresight UK (2011). *International Dimensions of Climate Change*. UK Government Office for Science, London.

FSB (Financial Stability Board) (2020). *The Implications of Climate Change for Financial Stability*. Available online: https://www.fsb.org/wp-content/uploads/P231120.pdf (accessed 25 March 2023).

Green, A.J. and Elmberg, J. (2014). Ecosystem services provided by waterbirds. *Biological Revi*ews 89(1): 105–122.

Hakala, E. (2022). Preparing for the storm: climate change and the Finnish model of comprehensive security. In: Iacovino, G. and Wigell, M. (eds), *Innovative Technologies and Renewed Policies for Achieving a Greener Defence.* Springer Netherlands, Dordrecht, the Netherlands, pp. 57–67.

Halleux, V. (2017). *Sustainable Tourism: The Environmental Dimension*. European Parliamentary Research Service. Available online: https://www.europarl.europa.eu/RegData/etudes/BRIE/2017/599327/EPRS_BRI(2017)599327_EN.pdf (accessed 10 March 2022).

Hanrahan, K. (2022). Safety net: food security in Ireland. Available online https://www.teagasc.ie/news--events/daily/food/safety-net-food-security-in-ireland.php (accessed 28 August 2022).

Harris, K., Lager, F., Jansen, M. and Benzie, M. (2022). Rising to a new challenge: a protocol for case-study research on transboundary climate risk. *Weather, Climate, and Society* 14(3): 755–768.

Hickman, C., Marks, E., Pihkala, P., Clayton, S., Lewandowski, R.E., Mayall, E.E., Wray, B., Mellor, C. and van Susteren, L. (2021). Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *The Lancet Planetary Health* 5(12): e863–e873.

Hildén, M., Groundstroem, F.M., Carter, T.R., Halonen, M., Perrels, A. and Gregow, H. (2016). Cross-border effects of climate change in Finland. *Publications of the Government's Analysis, Assessment and Research Activities* 46: 62.

Hocquet, R. (2021). *CASCADES' Conceptual Framework of Cascading Climate Impacts*. weADAPT. Available online: https://www.weadapt.org/knowledge-base/transnational-climate-impacts/cascades-conceptual-fr (accessed 5 October 2022).

IBEC (Irish Business and Employers' Confederation) (2019). *Building a Low Carbon Economy: A Roadmap for a Sustainable Ireland in 2050*. Available online: https://www.ibec.ie/-/media/documents/ibec-campaigns/cop26/building-a-low-carbon-economy.pdf (accessed 1 February 2024).

IPCC (Intergovernmental Panel on Climate Change) (2018). Summary for policymakers. In: Masson-Delmotte, V., Zhai, P., Pörtner, H.O. Roberts, D., Skea, J., Shukla, P.R., Pirani, A. Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J.B.R., Chen, Y., Zhou, X., Gomis, M.I., Lonnoy, E., Maycock, T., Tignor, M. and Waterfield, T. (eds), *Global Warming of 1.5°C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. Cambridge University Press, Cambridge, UK, and New York, NY, pp. 3–24.

IPCC (Intergovernmental Panel on Climate Change) (2022). Summary for policymakers. In: Pörtner, H.O., Roberts, D.C., Poloczanska, E.S., Mintenbeck, K., Tignor, M., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V. and Okem, A. (eds), *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, pp. 3–33.

IRGC (International Risk Governance Council) (2018). Guidelines for the governance of systemic risks. Available online: https://irgc.org/risk-governance/systemic-risks/guidelines-governance-systemic-risks-context-transitions/ (accessed 8 November 2022).

Irish Aid (2019). *A Better World: Ireland's Policy for International Development*. Available online: https://www.irishaid.ie/media/irishaid/aboutus/abetterworldirelandspolicyforinternationaldevelopment/A-Better-World-Irelands-Policy-for-International-Development.pdf (accessed 25 March 2023).

ITA (International Trade Association) (2022). Ireland – country commercial guide: agricultural sector. Available online: https://www.trade.gov/country-commercial-guides/ireland-agricultural-sector (accessed 6 February 2023).

Keenan, S. (2018). *Food Safety Situation in Ireland: Overview of the Directorate for Health and Food Audits and Analysis, DG SANTE*. European Commission Directorate-General for Internal Policies. Available online: https://www.europarl.europa.eu/RegData/etudes/STUD/2018/618982/IPOL_STU(2018)618982_EN.pdf (accessed 6 February 2022).

Kelly, B. and Stack, M. (2009). *Climate Change, Heritage and Tourism: Implications for Ireland's Coast and Inland Waterways*. The Heritage Council, Kilkenny, Ireland.

Kelly, J., Tosh, D., Dale, K. and Jackson, A. (2013). *The Economic Cost of Invasive and Non-native Species in Ireland and Northern Ireland. A Report Prepared for the Northern Ireland Environment Agency and National Parks and Wildlife Service*. Invasive Species Northern Ireland, Belfast, Northern Ireland.

Knaepen, H. and Vajpeyi, I. (2022). *European Responses to Transboundary Climate Impacts and Insecurity*. CASCADES. Available online: https://www.cascades.eu/wp-content/uploads/2022/10/CASCADES-European-responses-to-transboundary-climate-impacts-and-security.pdf (accessed 9 March 2023).

Lager, F. and Benzie, M. (2022). *New Risk Horizons: Sweden's Exposure to Climate Risk via International Trade*. Stockholm Environment Institute. Available online: https://www.sei.org/wp-content/uploads/2022/09/new-risk-horizons-sei2022.033.pdf (accessed 1 February 2024).

Levermann, A. (2014). Climate economics: make supply chains climate smart. *Nature* 506: 27–29.

Lewis, L., Coombes, D., Burke, B., O'Halloran, J., Walsh, A., Tierney, D. and Cummins, S. (2019). *Countryside Bird Survey: Status and Trends of Common and Widespread Breeding Birds 1998–2016*. Irish Wildlife Manuals No. 115. National Parks and Wildlife Service. Available online: https://www.npws.ie/sites/default/files/publications/pdf/IWM115.pdf (accessed 1 February 2024).

Loughlin, E. (2023). Ireland will need to give asylum to those fleeing climate change, Roderic O'Gorman says. *Irish Examiner*, 9 January 2023. Available online: https://www.irishexaminer.com/news/arid-41043809.html (accessed 10 March 2023).

Lucy, F., Caffrey, J. and Dick, J. (2021). *Invasive Alien Species in the Republic of Ireland: Policy Recommendations for Their Management. Report Prepared for the Water Forum*. Available online: https://thewaterforum.ie/app/uploads/2021/12/Lucy-et-al.-Invasive-Alien-Species-Report_Policy-Recommendations-for-their-Management.pdf (accessed 3 May 2023).

Ma, Y., Dixon, G. and Hmielowski, J.D. (2019). Psychological reactance from reading basic facts on climate change: the role of prior views and political identification. *Environmental Communication* 13(1): 71–86.

Mobjörk, M. (2012). *Klimatförändringarnas konsekvenser för samhällsskydd och beredskap*. MSB 349. Myndigheten för Samhällsskydd och Beredskap. Available online: https://rib.msb.se/filer/pdf/26173.pdf (accessed 30 November 2022).

Moser, S.C. and Hart, J.A.F. (2015). The long arm of climate change: societal teleconnections and the future of climate change impacts studies. *Climatic Change* 129: 13–25. https://doi.org/10.1007/s10584-015-1328-z

Opitz-Stapleton, S., Cramer, L., Kaba, F., Gichuki, L., Borodyna, O., Crane, T., Diabang, S., Bahadur, S., Diouf, A. and Seck, E. (2021). *Transboundary Climate and Adaptation Risks in Africa: Perceptions From 2021*. Overseas Development Institute, London, UK.

OPW (Office of Public Works) (2019). *Flood Risk Management: Climate Change Sectoral Adaptation Plan.* Available online: https://assets.gov.ie/46534/3575554721374f7ab6840ee11b8b066a.pdf (accessed 1 February 2024).

Osberghaus, D. (2019). The effects of natural disasters and weather variations on international trade and financial flows: a review of the empirical literature. *Economics of Disasters and Climate Change* 3(3): 305–325.

Peter, M., Guyer, M. and Füssler, J. (2019). *How Climate Change is Affecting German Foreign Trade: Consequences of Global Climate Change for Germany – Final Report*. Federal Environment Agency, Germany. Available online: https://www.umweltbundesamt.de/publikationen/folgen-des-globalen-klimawandels-fuer-deutschland (accessed 1 February 2024).

Peter, M., Guyer, M., Füssler, J., Bednar-Friedl, B., Knittel, N., Bachner, G., Schwarze, R. and Unger, M.V. (2020). *Impacts Global Climate Change for Germany. Final Report: Analyses and Policy Recommendations.* Umweltbundesamt, Germany.

Peter, M., Guyer, M., Füssler, J., Bednar-Friedl, B., Knittel, N., Wegener, B.G. and Schwarze, R. (2021). *The Transnational Impacts of Global Climate Change for Germany: Abridged Version*. Umweltbundesamt, Germany. Available online: https://www.umweltbundesamt.de/en/publikationen/the-transnational-impacts-of-global-climate-change (accessed 2 December 2022).

Phillips, C. and Murphy, C. (2021). Solastalgia, place attachment and disruption: insights from a coastal community on the front line. *Regional Environmental Change* 21(2): 46.

Phillips, C., Murphy, C. and Bresnihan, P. (2022). The impacts of and responses to place loss in a coastal community in Ireland. *Local Environment* 27(7): 879–896.

Prokkola, E.K., Niemi, S., Lépy, É., Palander, J., Kulusjärvi, O. and Lujala, P. (2021). *Climate Migration: Towards a Better Understanding and Management – Finland and a Global Perspective*. Prime Minister's Office, Helsinki. Available online: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/163182/VNTEAS_2021_42.pdf?sequence=4&isAllowed=y (accessed 25 January 2024).

Quinn, T., Heath, S., Adger, W.N., Abu, M., Butler, C., Nii Ardey Codjoe, S., Horvath, C., Martinez-Juarez, P., Morrissey, K., Murphy, C. and Smith, R. (2023). Health and wellbeing implications of adaptation to flood risk. *Ambio* 52(5): 952–962.

Reichel, B. (2021). *The Stakeholders of Transboundary Climate Risk Management*. Adelphi, Berlin. Available online: https://clic-climate.de/sites/clicclimate.de/files/documents/reichel_2021_the_stakeholders_of_transboundary_climate_risk_management.pdf (accessed 3 May 2023).

Rinaldi, S.M., Peerenboom, J.P. and Kelly, T.K. (2001). Identifying, understanding, and analyzing critical infrastructure interdependencies. *IEEE Control Systems Magazine* 21(6): 11–25.

Ryan, P., Hawchar, L., Naughton, O. and Stewart, M.G. (2021). *CIViC: Critical Infrastructure Vulnerability to Climate Change*. Environmental Protection Agency, Johnstown Castle, Ireland. Available online: https://www.epa.ie/publications/research/climate-change/Research_Report_369.pdf (accessed 25 January 2024).

Sargeant, T. (2020). North–South cooperation on the island of Ireland. Institute for Government. Available online: https://www.instituteforgovernment.org.uk/article/explainer/north-south-cooperation-island-ireland#references (accessed 7 February 2023).

Scally, D. (2022). European drought taking heavy toll on crops and shipping as costs soar. *Irish Times*, 9 August 2022. Available online: https://www.irishtimes.com/world/europe/2022/08/09/european-drought-taking-heavy-toll-on-crops-and-shipping/ (accessed 28 August 2023).

Schultze, L., Keskitalo, C., Bohman, I., Johannessin, R., Kjellström, E., Larsson, H., Lindgren, E., Storbjörk, S. and Vulturius, G. (2022). *Första Rapporten från Nationella Expertrådet för Klimatanpassning 2022.* Nationella expertrådet för klimatanpassning. Available online: https://klimatanpassningsradet.se/polopoly_fs/1.180289!/Rapport%20fr%C3%A5n%20Nationella%20expertr%C3%A5det%20f%C3%B6r%20klimatanpassning%202022.pdf (accessed 5 December 2022).

Schwartz, S.E., Benoit, L., Clayton, S., Parnes, M.F., Swenson, L. and Lowe, S.R. (2022). Climate change anxiety and mental health: environmental activism as buffer. *Current Psychology* 42: 16708–16721.

Smith, K. (2013). *Environmental Hazards: Assessing Risk and Reducing Disaster*. Routledge, London.

Studnicka, Z. and Lawless, M. (2018). *Cross-border Trade & Supply Chain Linkages Report*. Economic and Social Research Institute. Available online: https://enterprise.gov.ie/en/publications/publication-files/cross-border-trade-and-supply-chain-linkages.pdf (accessed 7 February 2023).

Trust, S., Joshi, S., Lenton, T. and Oliver, J. (2023). *The Emperor's New Climate Scenarios: Limitations and Assumptions of Commonly Used Climate Change Scenarios in Financial Services*. Institute and Faculty of Actuaries. Available online: https://actuaries.org.uk/media/qeydewmk/the-emperor-s-new-climate-scenarios.pdf (accessed 28 August 2023).

UNCTAD (United Nations Conference on Trade and Development) (2022). *Review of Maritime Transport*. United Nations Publications, New York. Available online: https://unctad.org/system/files/official-document/rmt2022_en.pdf (accessed 27 March 2023).

UNFCCC (United Nations Framework Convention on Climate Change) (2015). Paris Agreement. United Nations, Bonn.

Volz, U., Campiglio, E., Espagne, E., Mercure, J.F., Oman, W., Pollitt, H. and Svartzman, R. (2021). Transboundary climate-related risks: analysing the impacts of a decarbonisation of the global economy on international trade, finance, and money. Paper prepared for the 9th IMF Statistical Forum, 17–18 November.

Watkiss, P. and Betts, R.A. (2021). Chapter 2: Method. In: Betts, R.A., Haward, A.B. and Pearson, K.V. (eds), *The Third UK Climate Change Risk Assessment Technical Report*. Climate Change Committee, London.

WEF (World Economic Forum) (2023). *The Global Risks Report 2023*. Available online: https://www3.weforum.org/docs/WEF_Global_Risks_Report_2023.pdf (accessed 21 March 2023).

WHO (World Health Organization) (2015). What you need to know about Health in All Policies. Geneva. Available online: https://cdn.who.int/media/docs/default-source/mca-documents/rmncah/health-in-all-policies-key-messages-en.pdf?sfvrsn=a4982d1_1 (accessed 1 February 2024).

Willett, W., Rockström, J., Loken, B., Springman, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L.J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J.A., De Vries, W., Majele Sibanda, L., Afshin, A., Chaudhary, A., Herrero, M., Agustina, R., Branca, F., Lartey, A., Fan, S., Crona, B., Fox, E., Bignet, V., Troell, M., Lindahl, T., Singh, S., Cornell, S.E., Srinath Reddy, K., Narain, S., Nishtar, S. and Murray, C.J.L. (2019). Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *The Lancet* 393(10170): 447–492.

Wolf, M., Ölmez, C., Schönthaler, K., Porst, L., Voß, M., Linsenmeier, M., Kahlenborn, W., Dorsch, L. and Dudda, L. (2021). *Climate Impact and Risk Analysis 2021 for Germany. Sub-report 5: Risks and Adaptation in the Economy and Health Clusters*. Federal Environment Agency (UBA), Dessau-Roßlau, Germany. Available online: https://www.adelphi.de/de/system/files/mediathek/bilder/KWRA2021_Teilbericht_5_Cluster_Wirtschaft_Gesundheit_bf_210709.pdf (accessed 2 December 2022).

Abbreviations

AICBRN	All-Island Climate and Biodiversity Research Network
AWBI	Adaptation Without Borders Initiative
BIC	British-Irish Council
CASCADES	Cascading Climate Risks: Towards Adaptive and Resilient European Societies
CCRA	Climate Change Risk Assessment
CCRA3	Third UK Climate Change Risk Assessment Technical Report
DAERA	Department of Agriculture, Environment and Rural Affairs
DFAT	Department of Foreign Affairs and Trade
ICT	Information and communications technology
INNS	Invasive non-native species
MPA	Marine Protected Area
NAF	National Adaptation Framework
ND-GAIN	Notre Dame Global Adaptation Index
NSMC	North South Ministerial Council
OPW	Office of Public Works
SII	Shared Island Initiative
TCI Index	Transnational Climate Impacts Index
TCR	Transboundary climate risk
TCRII	Transboundary Climate Risks for the Island of Ireland

An Ghníomhaireacht Um Chaomhnú Comhshaoil

Tá an GCC freagrach as an gcomhshaol a chosaint agus a fheabhsú, mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ar thionchar díobhálach na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialáil: Rialáil agus córais chomhlíonta comhshaoil éifeachtacha a chur i bhfeidhm, chun dea-thorthaí comhshaoil a bhaint amach agus díriú orthu siúd nach mbíonn ag cloí leo.

Eolas: Sonraí, eolas agus measúnú ardchaighdeáin, spriocdhírithe agus tráthúil a chur ar fáil i leith an chomhshaoil chun bonn eolais a chur faoin gcinnteoireacht.

Abhcóideacht: Ag obair le daoine eile ar son timpeallachta glaine, táirgiúla agus dea-chosanta agus ar son cleachtas inbhuanaithe i dtaobh an chomhshaoil.

I measc ár gcuid freagrachtaí tá:

Ceadúnú

- Gníomhaíochtaí tionscail, dramhaíola agus stórála peitril ar scála mór;
- Sceitheadh fuíolluisce uirbigh;
- Úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe;
- Foinsí radaíochta ianúcháin;
- Astaíochtaí gás ceaptha teasa ó thionscal agus ón eitlíocht trí Scéim an AE um Thrádáil Astaíochtaí.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil

- Iniúchadh agus cigireacht ar shaoráidí a bhfuil ceadúnas acu ón GCC;
- Cur i bhfeidhm an dea-chleachtais a stiúradh i ngníomhaíochtaí agus i saoráidí rialáilte;
- Maoirseacht a dhéanamh ar fhreagrachtaí an údaráis áitiúil as cosaint an chomhshaoil;
- Caighdeán an uisce óil phoiblí a rialáil agus údaruithe um sceitheadh fuíolluisce uirbigh a fhorfheidhmiú
- Caighdeán an uisce óil phoiblí agus phríobháidigh a mheasúnú agus tuairisciú air;
- Comhordú a dhéanamh ar líonra d'eagraíochtaí seirbhíse poiblí chun tacú le gníomhú i gcoinne coireachta comhshaoil;
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Dramhaíola agus Ceimiceáin sa Chomhshaol

- Rialacháin dramhaíola a chur i bhfeidhm agus a fhorfheidhmiú lena n-áirítear saincheisteanna forfheidhmithe náisiúnta;
- Staitisticí dramhaíola náisiúnta a ullmhú agus a fhoilsiú chomh maith leis an bPlean Náisiúnta um Bainistíocht Dramhaíola Guaisí;
- An Clár Náisiúnta um Chosc Dramhaíola a fhorbairt agus a chur i bhfeidhm;
- Reachtaíocht ar rialú ceimiceán sa timpeallacht a chur i bhfeidhm agus tuairisciú ar an reachtaíocht sin.

Bainistíocht Uisce

- Plé le struchtúir náisiúnta agus réigiúnacha rialachais agus oibriúcháin chun an Chreat-treoir Uisce a chur i bhfeidhm;
- Monatóireacht, measúnú agus tuairisciú a dhéanamh ar chaighdeán aibhneacha, lochanna, uiscí idirchreasa agus cósta, uiscí snámha agus screamhuisce chomh maith le tomhas ar leibhéil uisce agus sreabhadh abhann.

Eolaíocht Aeráide & Athrú Aeráide

- Fardail agus réamh-mheastacháin a fhoilsiú um astaíochtaí gás ceaptha teasa na hÉireann;
- Rúnaíocht a chur ar fáil don Chomhairle Chomhairleach ar Athrú Aeráide agus tacaíocht a thabhairt don Idirphlé Náisiúnta ar Ghníomhú ar son na hAeráide;
- Tacú le gníomhaíochtaí forbartha Náisiúnta, AE agus NA um Eolaíocht agus Beartas Aeráide.

Monatóireacht & Measúnú ar an gComhshaol

- Córais náisiúnta um monatóireacht an chomhshaoil a cheapadh agus a chur i bhfeidhm: teicneolaíocht, bainistíocht sonraí, anailís agus réamhaisnéisiú;
- Tuairiscí ar Staid Thimpeallacht na hÉireann agus ar Tháscairí a chur ar fáil;
- Monatóireacht a dhéanamh ar chaighdeán an aeir agus Treoir an AE i leith Aeir Ghlain don Eoraip a chur i bhfeidhm chomh maith leis an gCoinbhinsiún ar Aerthruailliú Fadraoin Trasteorann, agus an Treoir i leith na Teorann Náisiúnta Astaíochtaí;
- Maoirseacht a dhéanamh ar chur i bhfeidhm na Treorach i leith Torainn Timpeallachta;
- Measúnú a dhéanamh ar thionchar pleananna agus clár beartaithe ar chomhshaol na hÉireann.

Taighde agus Forbairt Comhshaoil

- Comhordú a dhéanamh ar ghníomhaíochtaí taighde comhshaoil agus iad a mhaoiniú chun brú a aithint, bonn eolais a chur faoin mbeartas agus réitigh a chur ar fáil;
- Comhoibriú le gníomhaíocht náisiúnta agus AE um thaighde comhshaoil.

Cosaint Raideolaíoch

- Monatóireacht a dhéanamh ar leibhéil radaíochta agus nochtadh an phobail do radaíocht ianúcháin agus do réimsí leictreamaighnéadacha a mheas;
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha;
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta;
- Sainseirbhísí um chosaint ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Ardú Feasachta agus Faisnéis Inrochtana

- Tuairisciú, comhairle agus treoir neamhspleách, fianaise-bhunaithe a chur ar fáil don Rialtas, don tionscal agus don phobal ar ábhair maidir le cosaint comhshaoil agus raideolaíoch;
- An nasc idir sláinte agus folláine, an geilleagar agus timpeallacht ghlan a chur chun cinn;
- Feasacht comhshaoil a chur chun cinn lena n-áirítear tacú le hiompraíocht um éifeachtúlacht acmhainní agus aistriú aeráide;
- Tástáil radóin a chur chun cinn i dtithe agus in ionaid oibre agus feabhsúchán a mholadh áit is gá.

Comhpháirtíocht agus Líonrú

- Oibriú le gníomhaireachtaí idirnáisiúnta agus náisiúnta, údaráis réigiúnacha agus áitiúla, eagraíochtaí neamhrialtais, comhlachtaí ionadaíocha agus ranna rialtais chun cosaint chomhshaoil agus raideolaíoch a chur ar fáil, chomh maith le taighde, comhordú agus cinnteoireacht bunaithe ar an eolaíocht.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil

Tá an GCC á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóir. Déantar an obair ar fud cúig cinn d'Oifigí:

1. An Oifig um Inbhunaitheacht i leith Cúrsaí Comhshaoil
2. An Oifig Forfheidhmithe i leith Cúrsaí Comhshaoil
3. An Oifig um Fhianaise agus Measúnú
4. An Oifig um Chosaint ar Radaíocht agus Monatóireacht Comhshaoil
5. An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tugann coistí comhairleacha cabhair don Ghníomhaireacht agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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