Rialtas na hÉireann
Government of Ireland

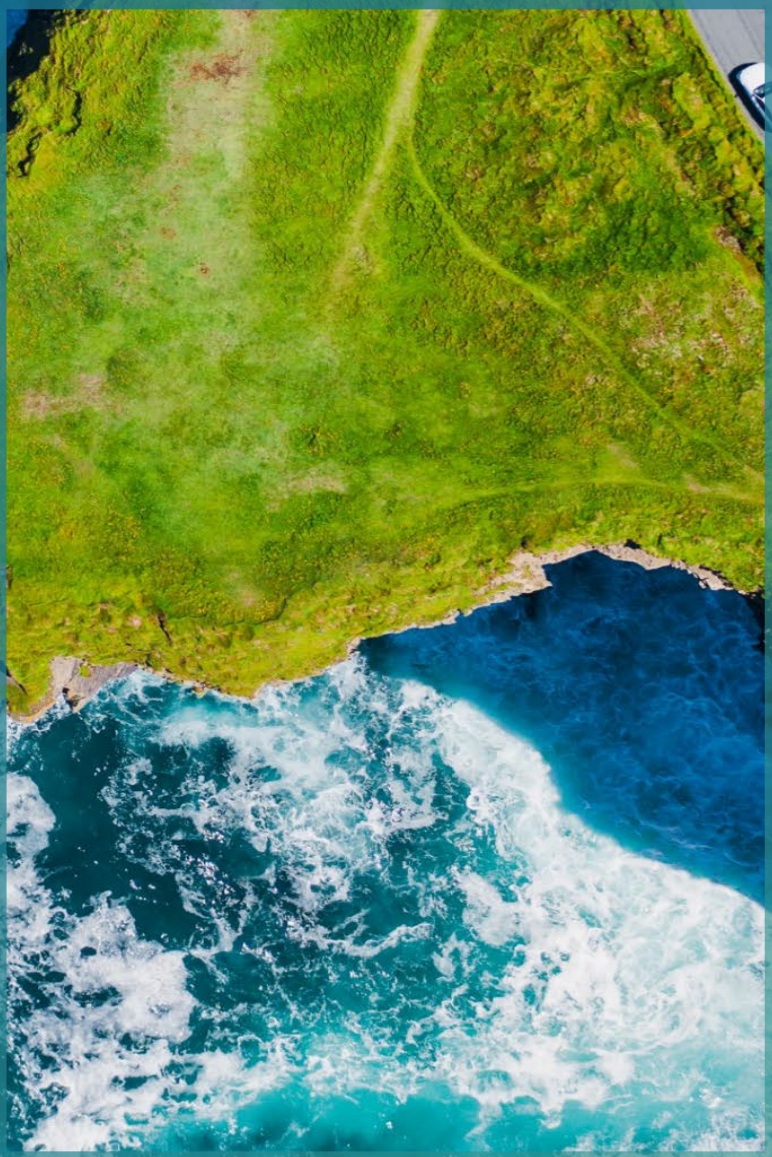
National Climate Change Risk Assessment

Methodology

Final

—

September 2024



Published by the Environmental Protection Agency

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Disclaimer

Acknowledgements

This Guidance was prepared on behalf of the EPA by KPMG Ireland. A steering committee was established to provide direction to the NCCRA process and to participate in reviews of NCCRA outputs, including this guidance document. The membership of the steering committee included representatives from: The Environmental Protection Agency, The Commission for the Regulation of Utilities, Department of Agriculture, Food and the Marine, Department of Defence - Office of Emergency Planning, Department of Environment, Climate and Communications, Department of Health, Department of Housing, Local Government and Heritage, Department of Tourism, Culture, Arts, the Gaeltacht, Sports, and Media , Department of Transport, Department of the Taoiseach, Met Éireann , National Economic and Social Council, National Parks & Wildlife Service, Office of Public Works, Teagasc.

The Guidance was also reviewed prior to finalisation by the NCCRA expert working groups comprising representatives from the following organisations: The Environmental Protection Agency, Atlantic Seaboard North, Atlantic Seaboard South, and Eastern & Midlands Climate Action Regional Offices, Central Statistics Office, Climate Change Advisory Council, Commission For Communications Regulation, Commission for the Regulation of Utilities, County and City

Management Association, Department of Agriculture, Food and the Marine, Department of Environment, Climate and Communications, Department of Health, Department of Housing, Local Government and Heritage, Department of Tourism, Culture, Arts, the Gaeltacht, Sports, and Media, Department of Transport, Dublin City University, Geological Survey Ireland, Health Service Executive, The Irish Climate Analysis and Research UnitS (ICARUS, Maynooth University), Irish Centre for High End Computing, The Marine Institute, Maritime Area Regulatory Authority, Met Éireann , National Economic and Social Council, National Parks & Wildlife Service, Office of Public Works.

Document Versions

Version	Changes
June 2024	Original published version
September 2024	• Amended risk statement to include confidence for both hazard and consequence • Added supporting information for the allocation of confidence • Updated category and consequence criteria to align with the published EU CRA criteria • Updated list of stakeholders • Added information on the alignment of the OPW flooding scenarios with RCP4.5 and RCP8.5 (Appendix 3)

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Executive Summary

There is a need to develop a consistent national climate change risk assessment for Ireland which identifies and prioritises climate change risks, both within and across sectors, to establish a national climate risk register that provides a basis for the development of consistent and integrated national and local adaptation plans and strategies. This need is explicitly recognised through Action 457 of Ireland's Climate Action Plan (2021) '*Further develop Ireland's national climate change risk assessment capacity to identify the priority physical risks of climate change to Ireland*.' The NCCRA outputs will be used to inform future Climate Action Plan updates.

The National Climate Risk Assessment (NCCRA) Methodology outlines the approach for the development and delivery of the first semi-quantitative NCCRA for Ireland. This methodology will provide the basis for an enduring national risk assessment process which can be iteratively updated to inform national climate action. The NCCRA will be delivered in three stages, underpinned by a preliminary stage:

Stage 0) Scope and Context: Outlines the scope, key criteria, information, and assumptions that used throughout the three stages of the NCCRA process. The NCCRA uses Representative Concentration Pathway (RCP) 4.5 (medium emissions) and RCP8.5 (high emissions) as the future climate scenario and assesses risk on the present (~2030), medium term (~2050) and long term (~2100) time frames.

Stage 1) Risk Identification: Stage 1 addresses two main questions: *How could Ireland be affected by climate change?* and *What could the consequence of these risks be?* Stage 1 involves a qualitative analysis of how Ireland is already and could be affected by future climate change to develop a preliminary understanding of the extent and consequence of climate risks and opportunities for Ireland. The qualitative analysis is informed by literature review and

stakeholder consultation with the outputs comprising a climate risk register, consisting of climate risk statements categorised across seven systems in line with the European Union Climate Change Risk Assessment.

Stage 2) Risk Assessment: Stage 2 addresses the question *Where and when might risks be realised?* Stage 2 involves a semi-quantitative assessment of the key risks identified in Stage 1 and will refine the understanding of the level of exposure, vulnerability, and consequence for each of the key risks. Stage 2 is informed by geospatial analysis, stakeholder engagement. through interviews and workshops, and existing information.

Stage 3) Urgency and Adaptation: Stage 3 addresses the questions *What is the management status of current and future risks?* and *What is the urgency of action?* Stage 3 is a qualitative assessment of the current and planned adaptation responses and the short-term (within the next five years) decision urgency required to manage each of the key risks to an acceptable level. Stage 3 is informed by existing information and stakeholder consultation through interviews and workshops.

Stakeholder engagement is a critical element of the NCCRA and is based on four key principles: Inform, Consult, Involve, and Develop. The stakeholder engagement process for the NCCRA incorporates four distinct phases: Method Development Engagement, Awareness Building, Risk Assessment Engagement and Final Report Engagement.

As part of the finalisation of the NCCRA, four main reports will be produced:

- **Main Report:** this report identifies climate change risks and opportunities. It provides a national risk register that outlines the most urgent risks and provides an overview of other priority risks and opportunities.

- **Technical Report:** this report details the evidence base which informs the risk assessment and makes up the current knowledge of climate change risks in Ireland.
- **Summary Report:** this report will be a succinct document which presents the policy-relevant aspects of the risk assessment in non-technical and accessible language.
- **Consultation Report**: this report will be a concise document which summarises the findings gathered from the various stakeholder engagement activities of the project.

1 Introduction

Ireland's climate is changing in line with global trends and this trend is expected to continue. Climate Change Risk Assessment (CCRA) forms a pre-requisite for the development of evidence based and robust climate change adaptation plans, providing an essential basis on making decisions on whether risks, and what level of those risks, are acceptable, and for developing appropriate adaptation and mitigation actions.

It is recognised that centrally produced national climate change scenarios, guidance and structured risk assessment processes can support closer integration and consistency across local and sectoral adaptation plans. To support this and at the European Union (EU) level, the first European Climate Risk Assessment (EUCRA) has been developed to provide an EU-wide point of reference for conducting and updating national or subnational climate risk assessments and has been designed to support the identification of adaptation-related policy priorities in Europe and policy development in climate-sensitive sectors during the next EU policy cycle.

For Ireland, through the development of the National Adaptation Framework (NAF, 2018), Climate Action and Low Carbon Development (Amendment) Act 2021, Climate Action Plan, and local and sectoral adaptation strategies, significant progress has been made in climate change risk assessment and adaptation planning. Individual stakeholders developed these strategies and plans using a range of different approaches, datasets, time periods and scenarios. These differences can lead to continued use of outdated climate modelling and scenarios and result in contradictory conclusions and policy decisions and hinder the ability to determine national priority risks.

Building on both international and national progress to date, there is a need to develop a consistent national climate change risk assessment for Ireland which identifies and prioritises climate change risks, both within and across sectors, and

provides a basis for the development of consistent and integrated national and local adaptation plans and strategies. This need is explicitly recognised through Action 457 of Ireland's Climate Action Plan (2021) '*Further develop Ireland's national climate change risk assessment capacity to identify the priority physical risks of climate change to Ireland*'.

Ireland's first National Climate Change Risk Assessment has the specific aim of:

- Identifying priority actions to make Ireland more resilient to the impacts of climate change.
- Supporting the prioritisation of adaptation-related investments in infrastructure and improve the robustness of policy development in climate-sensitive sectors.
- Providing a consistent evidence base on which to inform the National Adaptation Framework.
- Providing a national reference for conducting and updating sectoral, local, and other Ireland-specific risk assessments.

1.1 Purpose

This document (the NCCRA Methodology) outlines the approach for the development and delivery of the first semi-quantitative[1] NCCRA for Ireland. The NCCRA focuses on the risks to Ireland from hazards that are caused, exacerbated, or influenced by the physical impacts of climate change including both acute and chronic changes. Consideration is also given to transboundary and cascading climate risks and any benefits or opportunities arising from a

[1] Semi-quantitative climate risk assessments builds upon qualitative CCRAs and are often based on nationally consistent sources of climate change in combination with qualitative information (assigned a numeric value), expert judgement and elicitation and stakeholder knowledge. They provide for the identification and prioritisation of national climate change risks to assess adaptation urgency.

changing climate. More specifically, the purpose of the NCCRA Methodology is to:

- Outline the overall approach to identify and prioritise Ireland's climate-related risks and opportunities.
- Define the methodology that will be employed in the development of the NCCRRA.
- Detail the fundamental criteria and considerations underpinning the methodology.
- Document assumptions and dependencies.
- Outline the stakeholder engagement approach throughout the NCCRA.
- Provide a roadmap for future iterative revision of the NCCRA.

1.2 How was the NCCRA Methodology developed?

The NCCRA Methodology was developed by KPMG with support and guidance from the EPA and in consultation with two dedicated expert working groups which focused on climatic and socioeconomic considerations (Working Group 1) and thematic considerations (Working Group 2). Two Expert Working Group workshops were held on the 16th and 19th of February 2024. In addition, the methodology was informed by:

- The findings of the NCCRA scoping report commissioned by the EPA and produced by KPMG in Q1 2023.
- A review of the EU Climate Risk Assessment.
- A review of best practice semi-quantitative approaches to national climate risk assessment, e.g., European Union (EU), United Kingdom (UK), and New Zealand (NZ).
- Existing national approaches to CCRA (e.g., Technical Annex B of the Local Authority Climate Acton Plans [LACAP] Guidelines [DECC, 2023], Sectoral

Planning Guidelines for Climate Adaptation [DECC, 2018]) and outcomes of climate risk assessment (e.g., Sectoral Adaptation Plans [SAPs] and LACAPs).

- Standard assessment guidelines, e.g., ISO 14091 (Adaptation to Climate Change) and ISO 31000 (Risk Assessment).
- Academic research and reports, such as the Irish Climate Change Assessment (ICCA), Intergovernmental Panel on Climate Change (IPCC) Assessment Report 6 (AR6).

1.3 How does NCCRA methodology progress the understanding of climate risks and opportunities in Ireland?

Building on work undertaken to date, the methodology outlined in this report will progress the understanding of climate risks and opportunities in Ireland by:

- Establishing a robust and consistent method for national and sectoral climate change risk assessment in Ireland in line with international best practice, i.e., the European Climate Risk Assessment.
- Employing a standard set of climate and socio-economic projections to inform the assessment according to defined scenarios and time periods.
- Utilising a semi-quantitative approach to climate risk assessment to understand the temporal and spatial variation in the risk posed by climate hazards.
- Identifying and comparatively assessing risks within and across sectors – including cascading, transboundary and cross-cutting risks.
- Prioritising risk based on standardised definitions of consequence and decision urgency.
- Ensuring risks within and outside the existing Irish adaptation sectors are identified and assessed.

- Informing adaptation planning and investment by producing a prioritised list of climate change risks at a national level.
- Undertaking a comprehensive programme of stakeholder engagement to inform the NCCRA, engaging with a wide range of climate, socioeconomic, sectoral, and adaptation experts and organisations throughout the NCCRA process.

1.4 NCCRA Methodology Principles

The NCCRA Methodology was developed with the following principles, these principles have been informed by international best practice and the principles contained within the draft National Adaptation Framework 2024:

- **Collaboration and Empowerment:** The NCCRA Methodology should ensure that the process is participatory and enabling, including an extensive process of stakeholder engagement to ensure valuable expert and sectoral insights are captured throughout the process, that the process is relevant to all stakeholders and supports decision-making for climate change adaptation (NAF Principles: Local Knowledge and Community Engagement, Mobilise Existing and New Resources, Openness and Knowledge Transfer).
- **Robust:** The NCCRA Methodology should incorporate the best and most up-to-date available science and information. The NCCRA Methodology should follow international best practice and take the lessons learned from existing NCCRA processes (NAF Principles: Science-Based Decision-Making, Climate Scenarios, Just Resilience, Integrated Approach).
- **Account for Uncertainty:** Uncertainties are an inherent part of all projections of climate change and its impacts. They will never be fully eliminated but adaptation measures will be required, nonetheless. To account for this uncertainty, a precautionary approach is adopted where necessary (NAF Principles: Account for Uncertainty, Just Resilience).

- **Holistic:** The framework should consider current and future risks, assess interdependencies and accounts for complex, cascading and compounding risks (NAF Principles: Integrated Approach).
- **Iterative:** The NCCRA Methodology should be a foundation to repeat and iterate upon for future NCCRAs (NAF Principles: Adaptive Governance, Mobilise Existing and New Resources).
- **Actionable:** The NCCRA should communicate findings effectively, support improved climate risk decision making, align with national policy objectives and integrate with existing climate action frameworks, e.g., National Adaptation Framework and programmes (NAF Principles: Prioritise Adaptation Actions).

2 National Climate Change Risk Assessment Methodology

The NCCRA will be delivered in three stages, underpinned by a preliminary stage to set the scope and context for the NCCRA (Table 2.1). As shown in Figure 2.1, each stage of the NCCRA builds on each other to produce the final output, which is a prioritised list of national risks and opportunities (the National Climate Risk Register).

Stage	Purpose	Tasks	Output
0) Scope and Context	Outline the scope, key criteria, and information used throughout the NCCRA	• Literature review	Fundamental methodology components and criteria
1) Risk Identification	Undertake a high-level qualitative assessment of priority climate risks for Ireland and determine risks to consider in Stage 2.	• Risk Identification • Confidence • Validation of Climate risk Register	An initial national climate risk register which prioritises climate change risks
2) Risk Assessment	Undertake a semi-quantitative assessment of priority risks identified through Stage 1, accounting for hazard, exposure, and vulnerability, to support Stage 3 assessment.	• Development of Impact Chains • Exposure ad Vulnerability Assessment • Refine Magnitude of Consequence and Confidence	A detailed assessment of priority climate change risks accounting for where and when these risks might be realised.
3) Urgency and Adaptation	Consider existing and planned adaptation measures and the adequacy of these in minimising risks to an acceptable level.	• Review Current and Planned Adaptation Action • Decision Urgency	A final national climate risk register, accounting for existing and planned adaptation, prioritised based on decision urgency.

Table 2.1: An overview of the key stages of the NCCRA Methodology.

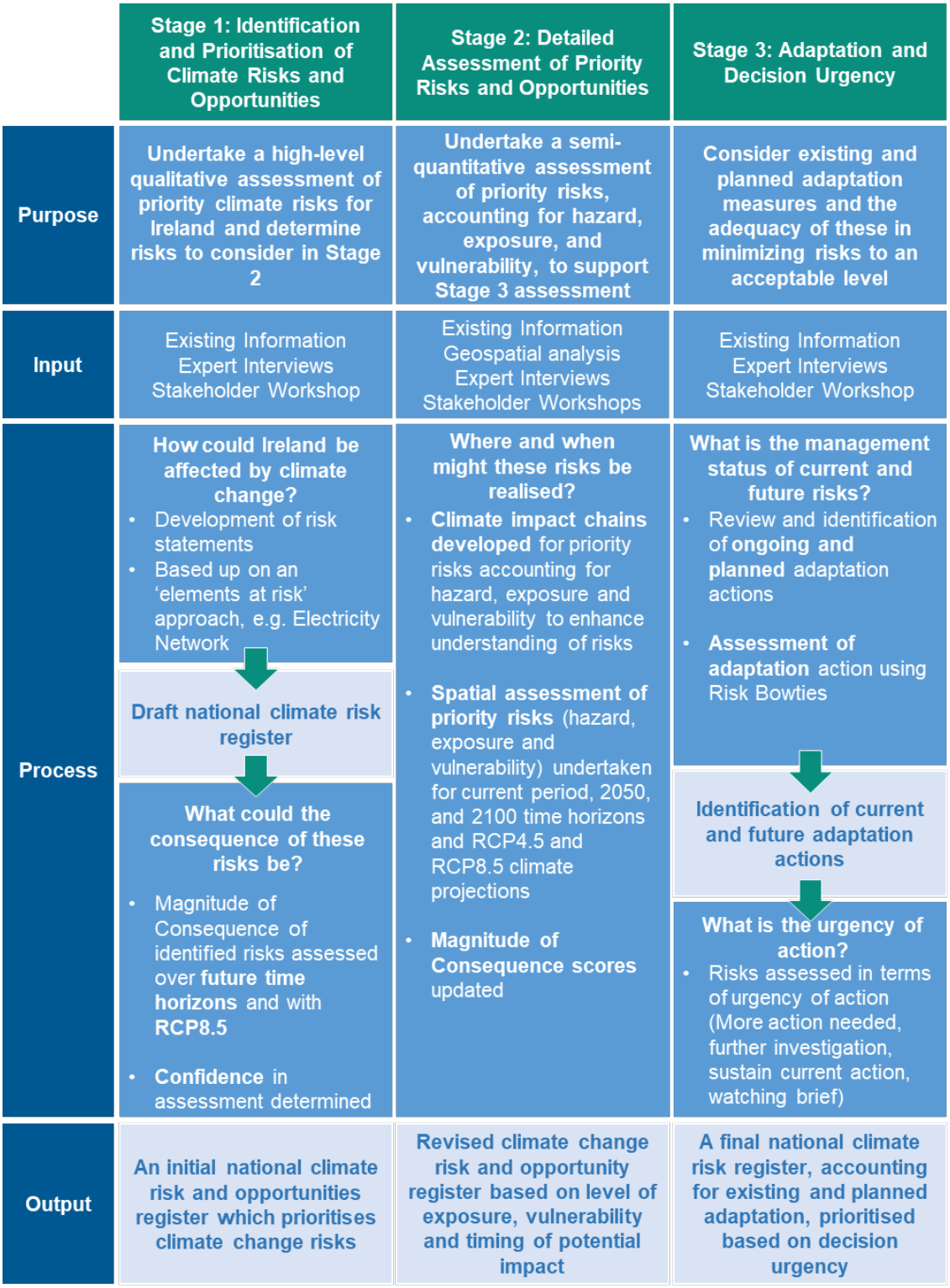

Figure 2.1 An overview of the three stages of the NCCRA Methodology

2.1 Stage 0: Scope and Context

This section describes the key components and assumptions that will be used throughout the NCCRA process. This includes:

- Definition of Climate Risk
- Systems, sub-systems, and Elements at Risk
- Interdependencies, cascading, direct and indirect, complex risk
- Transboundary Risk
- Timeframes
- Climate Projections
- Climate Hazards and Data Sources
- Socioeconomic Scenarios
- Spatial Units
- Magnitude of Consequence Criteria
- Confidence Criteria

2.1.1 Climate Risk Definition

The NCCRA follows the conceptual risk framework for climate change risks used within IPCC Assessment Report (AR6) (IPCC, 2023). In this framework, risk is a function of climate hazards, the degree assets are exposed to the hazard, and the vulnerability of the asset to the effects of the hazard (Figure 2.2 and Table 2.2). Risk is defined as the potential for adverse consequences for human or ecological systems. A ‘Key Risk’ is a risk that has potential to cause severe adverse consequences for humans and social-ecological systems. As the IPCC Risk Framework has been adopted for the NCCRA, the method components have been developed to align with this framework.

Assessing risks according to this framework does not require an assessment of likelihood of consequences, as the chronic nature of some climatic changes, e.g., sea level rise, make it difficult to estimate likelihood for some hazards.

The IPCC Risk Framework incorporates complex climate risks by showing the different ways in which risks can interact (Figure 2.3). This includes compounding risk in single or multiple directions, cascades with one event triggering another, and aggregate, e.g., with independent determinants of risks co-occurring.

Figure 2.2: Risk is a result of the interaction of climate-related hazards with the vulnerability and exposure of human and natural systems (O'Neill, 2022).

Risk Determinant	Definition
Hazard	The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.
Exposure	The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.
Risk	The potential for adverse consequences for human or ecological systems

Table 2.2: Definitions of the risk determinants from the Intergovernmental Panel on Climate Change (IPCC) Risk Framework

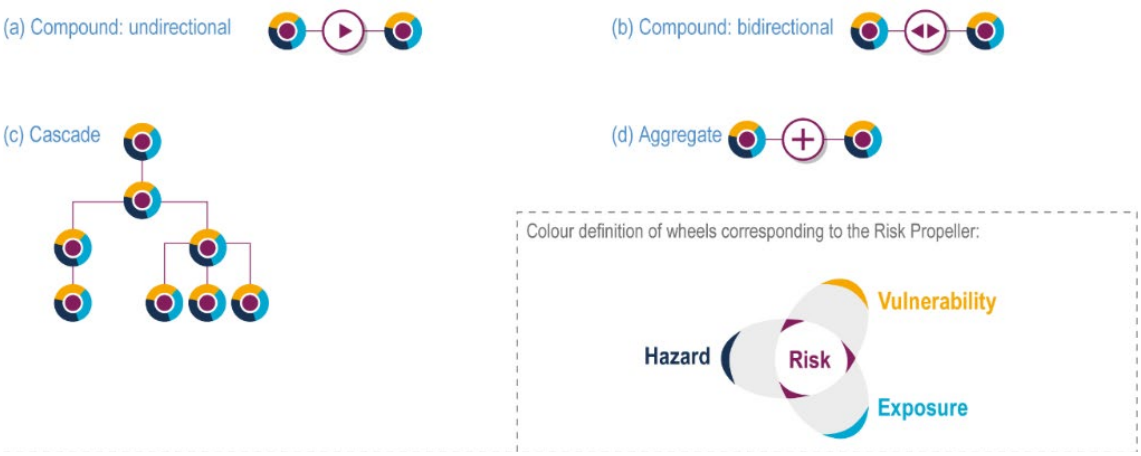

Figure 2.3: The potential interactions between climate risks O'Neill et al, 2022, adapted from Simpson et al., 2021).

To ensure consistency in the application of complex risk terms, the definitions of the complex risk terminology are shown in Table 2.3.

Complex Risk	Definition
Aggregate Risk	The accumulation of independent determinants of risk
Cascading Risk	One event or trend triggering others; interactions can be one way (e.g., domino or contagion effects) but can also have feedbacks; cascading risk is often associated with the vulnerability component of risk, such as critical infrastructure
Compound Risk	Compound risks arise from the interaction of hazards, which can be characterized by single extreme events or multiple coincident or sequential events that interact with exposed systems or sectors
Interacting Risk	The combinations of hazards and their reciprocal influences between different factors and coincidences among environmental drivers
Interdependent Risk	Complex systems involve interactions and interdependencies that cannot be separated and lead to a range of unforeseeable risks

Table 2.3: Definitions of different types of complex risk (Simpson et al. 2021).

2.1.2 Systems, Sub-Systems, and Elements at Risk

The NCCRA adopts a systems-based approach to support the identification and assessment of cross-cutting risks. Systems are a group of interacting or interrelated elements that provide nationally important functions (DCCEEW, 2023). Each system, e.g., Energy, is comprised of sub-systems, e.g., Energy Transportation and Distribution Grid, which are comprised of elements at risk, e.g., Electricity Network, (Figure 2.4). Elements at risk are objects, persons, animals, plants, activities, and processes of value to Ireland that may be exposed to climate change and potentially impacted, negatively or positively, directly or indirectly. Table 2.4 shows the systems, sub-systems, and elements at risk to be employed as part of the NCCRA.

The systems and sub-systems for Ireland are based upon approach used within the EU Climate Risk Assessment and are used as climate risk is inherently complex, with cross-cutting interactions. The NCCRA aims to identify and assess cross-cutting and complex interactions as much as feasibly possible (see Section 2.1.3) and this is supported by a systems-based approach.

To demonstrate this, Table 2.4 also shows an indicative assessment of the relevance, i.e., dependence or potential impact upon, of each element at risk to the Irish and EU Policy Sectors for Adaptation. This shows that a single element at risk can be relevant to numerous sectors, and that an individual sector relies and could impact upon a range of systems, sub-systems, and elements at risk. The Irish Policy Sectors for Adaptation overlap considerably with the EU Policy Sectors for Adaptation, except for Business and Industry, and Financial sectors, with the Flood Risk Management sector present in Ireland but not the EU.

It is important to note that the elements at risk shown in Table 2.4, can be considered broad classifications. For example, non-residential buildings would include buildings relevant to health, industry, culture/archaeology, education, sports, recreation, tourism etc. The elements are risk listed are therefore not exhaustive and will be refined and expanded during Stage 1 of the NCCRA along with a more detailed understanding of the cross-cutting relevance to the Irish sectors.

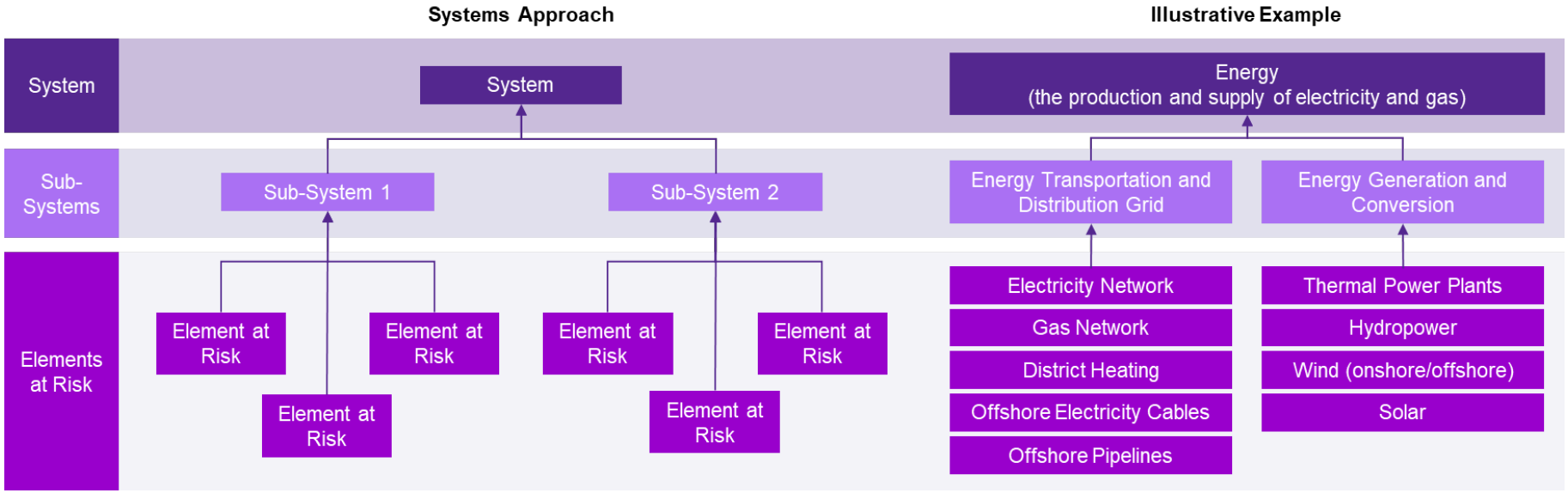

Figure 2.4: The relationship between systems, sub-systems, and elements at risk and an example from the Energy system.

System	Sub-system	Element at Risk[2]	Policy Sectors for Adaptation																						
		IE[3]	Agriculture	Biodiversity	Cross-cutting	Built and Arch. Heritage	Cross-cutting	Electricity and Gas Networks	Flood Risk Management[5]	Forestry	Health	Communication Networks	Seafood	-	Transport Infrastructure	Tourism	Water Qual. and Water Services Inf.	Planning[6]	Planning[6]	Planning[6]	-	-
		EU	Agriculture	Biodiversit	Coastal	Cultural heritage	Disaster Risk	Energy	-	Forestry	Health	ICT	Marine and Fisheries	Mountain areas[4]	Transport	Tourism	Water Manageme nt	Buildings	Planning	Urban	Business & Industry[4]	Financial[4]
Built Environ-ment	Buildings	Residential buildings			S	L			M									M	M	M	L	S
		Non-residential buildings	S		S	M	L	S	M	L	M	S	S		S	M	M	M	M	M	M	M
	Transport Infrastructure	Road	S		S		L		S						M	S			S	S	S	
		Rail	S		S				S						M	S			S	S	S	
		Air	S		L				L						M	S			S	S	S	
		Ports/Harbours	S		M				L						M	S			S	S	S	
	Communi-cation	Data Centres	L						L			M			L				L	L	S	
		Towers							L			M			L				L	L	S	
		Underground Infrastructure							L			M							L	L	S	
		Undersea cables			S							M									S	
	Water Services Infrastructure[1]	Water Treatment	L						L								M		L	L	S	
		Pipelines	M						L								M		L	L	S	
Energy		Electricity Network	S				L	M	L		S	S			M		M		L	M	S	

System	Sub-system	Element at Risk[2]	Policy Sectors for Adaptation																						
		IE[3]	Agriculture	Biodiversity	Cross-cutting	Built and Arch. Heritage	Cross-cutting	Electricity and Gas Networks	Flood Risk Management[5]	Forestry	Health	Communication Networks	Seafood	-	Transport Infrastructure	Tourism	Water Qual. and Water Services Inf.	Planning[6]	Planning[6]	Planning[6]	-	-
		EU	Agriculture	Biodiversit	Coastal	Cultural heritage	Disaster Risk	Energy	-	Forestry	Health	ICT	Marine and Fisheries	Mountain areas[4]	Transport	Tourism	Water Manageme nt	Buildings	Planning	Urban	Business & Industry[4]	Financial[4]		
	Energy Transportation and Distribution Grid	District Heating						M	L										L	L	L				
		Gas Network						M	L						S				L	L	S				
		Offshore pipelines			S			M											L						
		Offshore electricity cables			S			M											L						
	Energy Generation and Conversion	Thermal Power Plants						M	M										L		L				
		Hydropower						M	L								S		L		L				
		Wind (Onshore/Offshore)						M	L										L		L				
		Solar						M	L										L		L				
Food Production and Supply Chain	Food Production	Crops	M	S					L												S				
		Livestock	M	S					S												S				
		Fisheries/Aquaculture		S									M								S				
	Food Supply Chain	Food Distribution/ Transportation	S				L		S				S						L	L	S				
		Food Trade	S										S								S				

System	Sub-system	Element at Risk[2]	Policy Sectors for Adaptation																				
		IE[3]	Agriculture	Biodiversity	Cross-cutting	Built and Arch. Heritage	Cross-cutting	Electricity and Gas Networks	Flood Risk Management[5]	Forestry	Health	Communication Networks	Seafood	-	Transport Infrastructure	Tourism	Water Qual. and Water Services Inf.	Planning[6]	Planning[6]	Planning[6]	-	-
		EU	Agriculture	Biodiversit	Coastal	Cultural heritage	Disaster Risk	Energy	-	Forestry	Health	ICT	Marine and Fisheries	Mountain areas[4]	Transport	Tourism	Water Manageme nt	Buildings	Planning	Urban	Business & Industry[4]	Financial[4]
Health	Human Health	Public Health	L	M		L	M		M		M								L	S	S	S
	Labour Force	Labour	L	L			M		L		M								L	S	S	S
	Health System	Medical and Care Facilities	L				M		M		M				S				L	L	L	
Marine and Coastal Eco-systems	Coastal Ecosystems	Intertidal		M	M	L			S							S						
		Estuaries		M	M	L			L							S						
		Lagoons		M	M	L			L							S						
		Beaches		M	M	L			S							S			L			
		Cliffs		M	M	L										S			L			
		Machair		M	M	L										S			L			
		Sand Dunes		M	M	L			S							S						
	Marine Ecosystems	Marine Life		M	L	L							M			L						
		Oceans/Seas		M		L							M			L						
Biodiversity and Eco-systems	Forests	Natural Forests		M		L				M						L						
		Managed Forests		M		L				M						L			L			
	Peatlands	Bogs	L	M		L			L							L	L					
		Fens	L	M		L			L							L	L					

System	Sub-system	Element at Risk[2]	IE[3]	Agriculture	Biodiversity	Cross-cutting	Built and Arch. Heritage	Cross-cutting	Electricity and Gas Networks	Flood Risk Management[5]	Forestry	Health	Communication Networks	Seafood	-	Transport Infrastructure	Tourism	Water Qual. and Water Services Inf.	Planning[6]	Planning[6]	Planning[6]	-	-
			EU	Agriculture	Biodiversit	Coastal	Cultural heritage	Disaster Risk	Energy	-	Forestry	Health	ICT	Marine and Fisheries	Mountain areas[4]	Transport	Tourism	Water Manageme nt	Buildings	Planning	Urban	Business & Industry[4]	Financial[4]
		Mires		L	M		L			L							L	L					
	Freshwater Systems	Rivers/streams		L	M		L										S	S					
		Lakes		L	M		L			L							S	S					
		Wetlands		L	M		L										S	S					
		Turloughs		L	M		L			L							S	S					
	Mountains and Uplands[1]	Heath			M		L								M		S						
	Urban Ecosystems	Sustainable Urban Drainage (SuDs)			M		L			L							S	L		L			
		Parks			M		L			L							S	L		L			
		Trees			M		L			L							S	L		L			
	Agroecosystems	Cropland		M	M		L			L							L					L	
		Orchards		M	M		L			L							L					L	
		Pasture		M	M		L			L							L					L	
Water Security	Water Supply[1]	Environment		S						S								M		L		L	
		Agricultural Use		M														M		L		S	

System	Sub-system	Element at Risk[2]	Policy Sectors for Adaptation																						
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		Civil and Domestic Use									S					S	M	L	L	L	S	
		Industry and Service Use															M		L	L	S	
		Energy Use															M		L		S	S

Table 2.4: The systems, sub-systems, and elements at risk to be used within the NCCRA and an indicative assessment of the relevance of the Irish (IE) and European Union (EU) Policy Sectors for Adaptation and the elements at risk. M = Most Relevance, S = Some Relevance, L = Low Relevance. [1]Added into to align the EU CCRA systems and sub-systems to the Irish context. [2]Elements at risk are not exhaustive and will be refined and expanded during Stage 1 of the NCCRA (Risk Identification). [3]Irish sectors are based on the draft NAF2024. [4]No corresponding Irish adaptation sector. [5]No corresponding EU Policy Sector for Adaptation. [6]Buildings, Planning, and Urban Sectors have been combined into a single Planning sector within the draft NAF2024.

2.1.3 Interdependencies, cascading, direct and indirect, complex risk

Complex risks result from multiple climate hazards occurring concurrently, and from multiple risks interacting, compounding overall risk, and resulting in risks transmitting through interconnected systems and across regions (O'Neill et al., 2022). Previous climate risk assessments in Ireland have not sufficiently focussed upon complex risks, due to the limited information available to assess these risks. However, despite these limitations, it is important that through the NCCRA process, complex risks are considered to sufficiently describe climate risks. It will not be possible to completely capture all the complex risks associated with climate change in Ireland, however, the NCCRA aims to identify and assess the key interacting, cascading, and compounding risks as reasonably possible.

2.1.4 International and Transboundary Risk

The NCCRA recognises the potential consequences of transboundary risk for Ireland. However, there is insufficient data and information to fully assess international and transboundary issues, consequently the first iteration of the NCCRA will not assess international and transboundary issues fully and will only assess these in relation to key risks where sufficient evidence is available. The NCCRA also recognises that transitioning to a low-carbon economy can entail extensive policy, legal, technology and market changes to address mitigation and adaptation requirements related to climate change, and depending on the nature, speed, and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organizations (IPCC, 2020). The NCCRA has a focus of assessing physical risks and therefore excludes transition risks.

2.1.5 Timeframes for Assessing Risk

The NCCRA will assess the current level of risk, and for two future time periods that present the medium term, around 2050, and in the long term, around 2100

(Table 2.5). These future time horizons were selected as 2050 and 2100 align with international climate goals, allow the consideration of long-term impacts, have relevance for infrastructure planning, and are used extensively in climate projection and scenario modelling.

Timeframe	Description
Present	Risks already occurring, up to 2030.
Medium term	Risks that may occur around 2050.
Long term	Risks that may occur around 2100.

Table 2.5: Risk assessment timeframes

2.1.6 Climate Projections

Climate change is already impacting upon Ireland, however, to inform the risks associated with projected climate change, climate risks need to be assessed in the context of future scenarios representing differing levels of atmospheric greenhouse gas concentrations and global temperatures. Different future scenarios are used within climate risks assessments to reduce uncertainty associated with the identification and assessment of future risks. For instance, the IPCC AR5 (IPCC, 2014) used four Representative Concentration Pathways (RCPs) to represent different levels of climate change: RCP2.6, RCP4.5, RCP6.0, and RCP8.5.

Ireland has committed to halving greenhouse gas emissions by 2030 and reaching net zero by 2050 at the latest. However, the degree of physical risks that Ireland will experience is dependent upon the success of global efforts to reduce greenhouse gas emissions. Therefore, even if Ireland meet's its greenhouse gas emissions targets, it could still be impacted by high levels of global warming due to inadequate emission reduction measures being pursued at the global scale. Consequently, there is uncertainty in the future climate that Ireland will be exposed to.

In the NCCRA, a conservative approach is taken to assess risks to Ireland and assumes global emission reduction targets are not met. This aligns with the principle of precaution as stated in the draft NAF 2024, and follows the approach used within the NZ CCRA (Ministry for the Environment, 2020). As a result, within the NCCRA, RCP8.5 and RCP4.5 are adopted to assess risks to Ireland:

- RCP8.5 was selected as it represents a high-emissions scenario and achieves the highest level of modelled temperature increases by the end of the century. Consequently, this scenario will result in the highest level of physical risk for Ireland, and therefore the require the greatest requirement for adaptation. Using RCP8.5 aligns with a conservative approach to the NCCRA and will be used as part of Stage 1 and Stage 2 assessments.

- RCP4.5 was selected as it represents a moderate-emissions scenario. RCP4.5 is more closely aligned with current levels of global climate action and policies than RCP8.5, and therefore can be considered aligned with the global temperature trajectory. RCP4.5 will be used in Stage 2 of the NCCRA in addition to RCP8.5.

RCP2.6, a low-emissions scenario, is not used as within this scenario physical risks are lower than RCP8.5, and RCP4.5, and is more applicable to assess risks associated with the transition to a carbon neutral economy. Transition risks are outside the scope of this NCCRA.

Standardised climate projections for Ireland based upon Shared Socioeconomic Pathways (SSPs) are not yet available.

2.1.7 Relevant Hazards and Data Sources

As shown in the IPCC Risk Framework, hazards are one of the determinants of climate risk. In the context of the NCCRA, the term hazard refers to the potential occurrence of a natural or human-induced physical event or trend or physical

impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.

Climate change will modify the magnitude, persistence, and frequency of hazard events, and alter the climatic conditions that can trigger or exacerbate the hazards, also known as climate impact drivers.

Through a review of existing information and stakeholder engagement, the hazards that will be considered within Stage 1 and Stage 2 of NCCRA have been identified (Table 2.6) based on current and expected hazard occurrence in Ireland. The changes in the hazards will be determined for each climate change scenario and time horizon.

To inform the spatial distribution and changes in frequency or intensity of each of the hazards, suitable spatial data has been identified based on the following criteria:

- The data must have national coverage.
- The data must be available for the current and future time horizons that align/could align with RCP4.5 and RCP8.5
- The data must be published to allow transparency of approaches and assumptions.
- Easily accessible to users

The data that meet these criteria are categorised as ‘primary’ data sources. Where primary data sources for a hazard do not exist, ‘secondary’ data sources have been identified that meet some of the above criteria (Table 2.6). Qualitative information, such as academic articles, research reports, incident reports will also be used to inform the hazards where applicable.

Type	Hazard	Data Sources		Comment
		Primary	Secondary	
Hot and Cold	Changes in Air Temperature	Mean Temperature (TRANSLATE)		
	Changes in Water Temperature	Mean Temperature (TRANSLATE)		
	Heatwaves	Maximum Temperature (TRANSLATE) Nights >15°C (TRANSLATE) No. of Heatwaves (TRANSLATE)		
	Frost/Ice	Icing Days (Nolan and Flanagan, 2020)		
	Changes in Phenology		Growing Season Length (Nolan and Flanagan, 2020)	
	Snowfall	Snowfall (Nolan and Flanagan, 2020)		
Wet and Dry	Changes in Precipitation	Mean Precipitation (TRANSLATE)		

Type	Hazard	Data Sources		Comment
		Primary	Secondary	
	Extreme Precipitation	Wet days (>20 mm) (TRANSLATE) Very wet days (>30 mm) (TRANSLATE) Maximum daily precipitation (TRANSLATE)		
	Drought (Meteorological)	Mean Precipitation (TRANSLATE) RR1 (TRANSLATE)		
	Drought (Environmental)		HydroPredict (Meresa and Murphy, 2023; Meresa et al., 2022, Murphy et al., 2023)	
	Hail		Academic Literature Reports	
	Fire Weather	TRANSLATE		Met Éireann to produce fire weather outputs via NFCS

Type	Hazard	Data Sources		Comment
		Primary	Secondary	
	River Flooding	OPW CFRAM/PFRAM Water resources and Eflows (EPA to produce in coordination with NFCS)	Water resources and Eflows (EPA hydrotool with modifying coefficients based on HydroPredict	OPW Scenarios require alignment with RCPs
	Surface Water Flooding	Wet days (>20 mm) (TRANSLATE) Very wet days (>30 mm) (TRANSLATE)	GSI	GSI Surface Water Flooding data is only available for Dublin and does not include future scenarios
	Groundwater Flooding		GSI	Current, GSI Groundwater Flooding data does not include future scenarios but is being updated.
Wind	Changes in wind	Average Wind Speed (Nolan and Flanagan (2020))		
	Storms		Nolan and Flanagan (2020)	

Type	Hazard	Data Sources		Comment
		Primary	Secondary	
Coastal and Marine	Coastal Erosion		GSI Coastal Vulnerability Irish Coastal Protection Strategy Study (ICPSS)	Coastal erosion linked with sea level rise.
	Coastal Flooding	OPW National Coastal Flood Hazard Mapping		
	Changes in Sea Temperature	Sea Surface Temperature (IPCC AR6)		Global dataset
	Marine Heatwaves		Marine Institute	
	Changes in Ocean Chemistry	pH at Surface (IPCC AR6)		Global dataset
	Sea Level Rise	Sea Level Projections (UKCP18) OPW National Coastal Extreme Water Level Estimation		OPW Scenarios require alignment with RCPs
Others	Air Pollution		Academic Literature Reports	
	Lightning		Academic Literature	

Table 2.6: The hazards that will be considered within the NCCRA.

2.1.7.1 OPW Scenario Alignment

The Mid-Range Future Scenario (MRFS) and High-End Future Scenario (HEFS) used by the OPW for river and coastal flooding projections are determined by potential future increases in precipitation/peak flood flow and mean and sea level and a future timeframe is not directly assigned to the MRFS and HEFS. For the NCCRA, the OPW scenarios have been aligned to the RCP4.5 and RCP8.5 scenarios, and 2030, 2050, and 2100 time horizon for river (Table 2.7) and coastal flooding (Table 2.8). The approach used to align these scenarios is outlined Appendix 3.

Annual Exceedance Probability	Present Day	RCP4.5		RCP8.5	
		2050	2100	2050	2100
5%	5% (Present)[1]	5% (MRFS)[1]	5% (MRFS)[1]	5% (MRFS)[1]	NIFM: 5% (HEFS) CFRAM: 1% (Present)
1%	1% (Present)[1]	1% (MRFS)[1]	1% (MRFS)[1]	1% (MRFS)[1]	1% (HEFS)[1]
0.1%	0.1% (Present)[1]	0.1% (MRFS)[1]	0.1% (MRFS)[1]	0.1% (MRFS)[1]	0.1% (HEFS)[1]

Table 2.7: The representative river flood extents that will be used within the NCCRA for each Annual Exceedance Probabilities and future changes in precipitation under RCP4.5 and RCP8.5 scenarios. [1]Both NIFM and CFRAM data are used for the AEP/Scenario.

Annual Exceedance Probability	RCP4.5		RCP8.5	
	2050 (SLR: 0.25 m)	2100 (SLR: 0.62 m)	2050 (SLR: 0.27 m)	2100 (SLR: 0.81 m)
50%	5% (Present)	20% (MRFS)	5% (Present)	5% (MRFS)
20%	2% (Present)	10% (MRFS)	2% (Present)	1% (MRFS)
10%	1% (Present)	5% (MRFS)	0.5% (Present)	1% (MRFS)
5%	1% (Present)	2% (MRFS)	0.5% (Present)	20% (HEFS)
2%	20% (MRFS)	1% (MRFS)	10% (MRFS)	10% (HEFS)
1%	5% (MRFS)	0.5% (MRFS)	5% (MRFS)	5% (HEFS)
0.5%	5% (MRFS)	10% (HEFS)	5% (MRFS)	2% (HEFS)
0.1%	1% (MRFS)	5% (HEFS)	0.5% (MRFS)	0.5% (HEFS)

Table 2.8: The representative coastal flood extents that will be used within the NCCRA for each Annual Exceedance Probabilities and future sea level under RCP4.5 and RCP8.5 scenarios.

2.1.8 Socioeconomic Projections

In addition to the changes expected in future climate and hazards, it is necessary to also account for changes in socioeconomics and demographics of the population to assess the exposure and vulnerability determinants of future risks more accurately, where feasible. For example, an ageing population will result in higher levels of vulnerability to some hazards in the future.

In Ireland, the CSO has modelled future population and labour force for the period 2017 to 2051 at the national level and for six scenarios (Figure 2.5). Population projections for the period 2017-2036 based on the NUTS 3 regions are also available including data on regional births, deaths and net internal and international migration classified by gender for each year. The Economic and Social Research Institute (ESRI) is currently updating the population projections

as part of the National Planning Framework revision. If available, these projections will be used within the NCCRA.

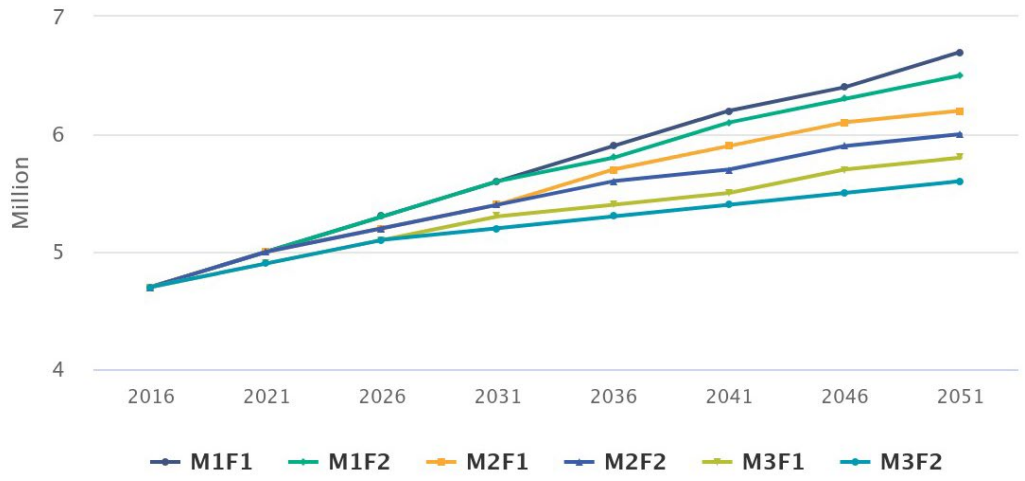

Figure 2.5: Example of the population projections for Ireland to 2051 based on six scenarios. Source: CSO Ireland.

The population projections will be used to qualitatively inform potential changes in exposure and vulnerability into the future. National population projections for the present and medium-term (2050) are available, however, long-term population projections are not currently available.

2.1.9 Spatial Regions

The NCCRA is a national scale assessment, however, it will consider climate projections, hazards and risks and opportunities across eight sub-national regions. These regions are based on the NUTS (Nomenclature of Territorial Units for Statistics) classification, a geocode standard for the European Union (EU). These NUTS regions are used for collecting statistics, analysing socio-economic trends, and supporting EU regional policies. In Ireland, it includes three hierarchically levels, which are ultimately based upon the boundaries of the Irish counties.

Where information is available, risks will be identified at the NUTS 3 or county level, however, all risks will be aggregated and assessed at the national level (NUTS 1) (Table 2.7). The relevant NUTS level will be used to support qualitative description of risks if necessary. A visual representation of the NUTS 3 Regions of Ireland is shown in Figure 2.6, with a hierarchical breakdown according to county outlined in Table 2.9.

For the marine environment, the Irish Exclusive Economic Zone (EEZ) will be used as the outer limit of assessment (200 nautical miles, 370.4 km offshore), with Transitional Waters (12 nautical miles, 22.2 km offshore) also used if required (Figure 2.7). The EEZ and Territorial Waters region can be described according to the seas they intersect, such the Irish Sea and St. George's Channel, the Celtic Sea, the North Atlantic Ocean, and the Inner Seas off the West Coast of Scotland. The Irish Internal Waters marine boundary will also be used to describe the internal bays, estuaries, and coastal waters around the Irish coastline and the zone designated for the Water Framework Directive as the Coastal Waterbody unit.

Figure 2.6: The NUTS 3 Regions of Ireland.

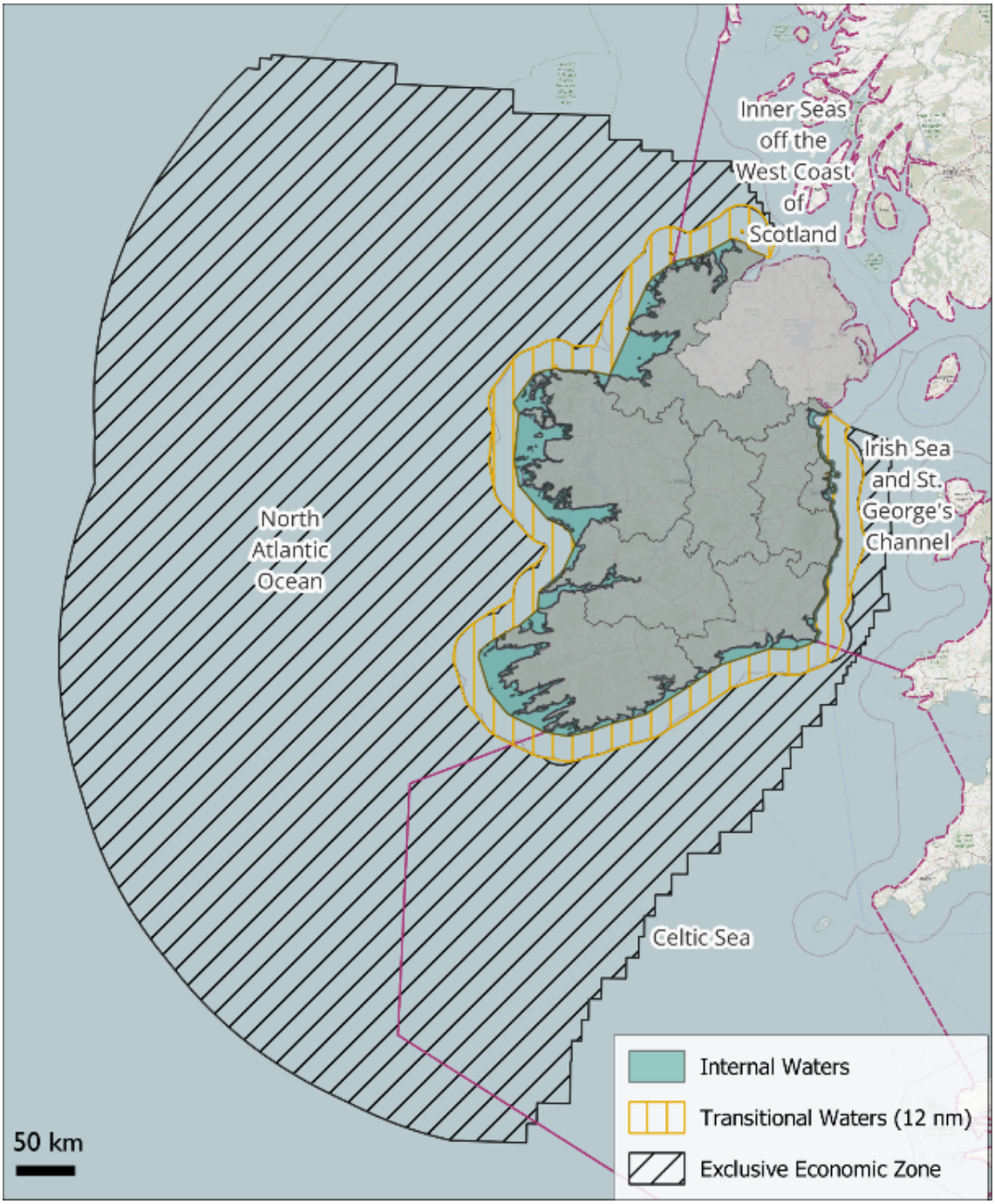

Figure 2.7: The marine environment regions (right). Basemap data from OpenStreetMap.

NUTS 1	NUTS 2	NUTS 3	Local Authorities
Ireland	Northern and Western Region	Border	Cavan
			Donegal
			Leitrim
			Monaghan
			Sligo
		West	Galway City
			Galway
			Mayo
			Roscommon
	Southern Region	Mid-West	Clare
			Limerick City and County
			Tipperary
		South-East	Carlow
			Kilkenny
			Waterford City and County
			Wexford
		South-West	Cork
			Cork City
			Kerry
	Eastern and Midland Region	Dublin	Dublin City
			Dún Laoghaire–Rathdown
			Fingal
			South Dublin
		Mid-East	Kildare
			Louth
			Meath
			Wicklow
		Midland	Laois
			Longford
			Offaly
			Westmeath

Table 2.9: The NUTS Regions Hierarchy and the corresponding Local Authorities areas.

2.1.10 Criteria for Assessing Risk: Magnitude of Consequence

When assessing and prioritising climate risks, an assessment of consequence of each risk is required. Table 2.10 shows the magnitude of consequence criteria to

be employed as part of the NCCRA. The categories of consequence are based on the EU CRA (2024).

Risk Severity	Damage	System Functionality	Extent and Pervasiveness	Cascading Effects
Catastrophic	Very large and frequent	Irreversible loss	Very large extent or very high pervasiveness	Irreversible cascading effects beyond system boundaries
Critical	Large and frequent	Long-term disturbance	Large extent and high pervasiveness	Long-term cascading effects beyond system boundaries
Substantial	Substantial losses	Temporary or moderate disturbance	Moderate extent or pervasiveness	Temporary cascading effects beyond system boundaries
Limited	Limited or rare losses	No significant disturbance	Limited extent or pervasiveness	No cascading effects beyond system boundaries

Table 2.10: Magnitude of consequence criteria based on the EU CRA (2024).

To support the assessment of consequence for each risk, the criteria shown in Table 2.11 can be used. These criteria are based on the European Climate Change Risk Assessment (2024); however, absolute thresholds have been adjusted for the Irish GNI* (Central Statistics Office, 2024), population (Central Statistics Office, 2023) and area (EPA, 2023).

Risk Severity	Economic Damage	Impact on People	Other Impact Categories
Catastrophic	At least 1% of GNI* (IE: €2.91 bn)	> 100 deaths or >1,000 health impacts or >10,000 people affected	• >710,000 ha of land lost or severely damaged (10% of land area)
Critical	0.25-1% of GNI* (IE: ca €727.5 mn - 2.91 bn)	>10 - 100 deaths or >100 - 1,000 health impacts or >100 - 10,000 people affected	• 71,000 ha to 710,000 of land lost or severely damaged • Major impact (10% or more) on valued habitat or landscape types; • Major impacts on or loss of species groups; • Major impact (10% or more) on an individual natural capital asset and associated goods and services; • Major loss or irreversible damage to iconic heritage assets
Substantial	0.05-0.25% of GNI* (IE: ca €145.5 mn - 727.5 bn)	>1 - 10 deaths or >10 - 100 health impacts or >100 - 1,000 people affected	• 7,100 to 71,000 ha of land lost or severely damaged • Intermediate impact (1-10%) on valued habitat or landscape types; • Intermediate impacts on or loss of species groups; • Intermediate impact (1-10%) on an individual natural capital asset and associated goods and services; • Medium loss or irreversible damage of iconic heritage assets.
Limited	<0.05% of GNI* (IE: ca < €145.5 mn)	≤1 death and ≤10 health impacts and ≤100 people affected	• Less than 7,100 ha of land lost or severely damaged • Minor impact (less than 1%) on valued habitat or landscape types; • Minor impacts on loss of species groups; • Minor impact (less than 1%) on an individual natural capital asset and associated goods and services; • Low loss or irreversible damage to iconic heritage assets.

Table 2.11: Risk consequence for different types of impacts — benchmarks based on annualised impacts. Based on EU CRA (2024) with absolute thresholds adjusted for the 2023 Irish GNI*, population or area (2024).

2.1.11 Confidence Criteria

A level of confidence rating is required for each of the identified risks. The NCCRA will use confidence criteria used in the IPCC AR5 (IPCC, 2014) and AR6 (IPCC, 2023) based on Mastrandrea et al. (2011).

Agreement ↑			
	High Agreement Limited Evidence (Medium)	High Agreement Medium Evidence (High)	High Agreement Robust Evidence **(Very High)**
	Medium Agreement Limited Evidence (Low)	Medium Agreement Medium Evidence (Medium)	Medium Agreement Robust Evidence (High)
	Low Agreement Limited Evidence (Very Low)	Low Agreement Medium Evidence (Low)	Low Agreement Robust Evidence (Medium)
	Evidence (type, amount, quality, consistency) →		

Table 2.12: Confidence criteria that will be applied to each risk, based on Mastrandrea et al., 2011.

As shown in Table 2.12, the criteria use the level of robustness of evidence and the level agreement between available information to assess overall confidence. This will be applied qualitatively with a confidence level given for the hazard and consequence of each risk and considering the confidence across the three-time horizons. The qualifiers used to express a level of confidence will be Very low, Low, Medium, High, and Very high. Information such as academic literature, reports, climate projections, and data, can be used to inform levels of confidence.

To support the operationalisation of the criteria in Table 2.10, elements of the GRADE-CERQual approach (Lewin et al. 2018) used by Berrang-Ford et al. (2021) can be used to inform the allocation of confidence (Table 2.13).

	Agreement	Robustness
High	No or very minor concerns about the extent to which the underlying literature is consistent with the key statement; This could be assessed by number cutoffs but also requires judgement. For example, if a supermajority of sources agrees to the answer (e.g., >70% of sources agree is High, 20% medium, and 10% low).	No or very minor concerns about the extent to which the underlying literature is consistent with the key statement; You feel certain that there is good quality evidence upon which to base the conclusions drawn; Numerous sources provide an answer to the question; They address the issue directly (not inferred by coders), and have no methodological concerns (e.g., they have large sample sizes or detailed case sources)
Medium	Minor to moderate concerns about the extent to which the underlying literature is consistent with the key statement; This could be assessed by number cut-offs but also requires judgement. For example, if a majority of sources agree to the answer (e.g., 50% of sources agree is High, 40% medium, 10% low); This could also include the case where the answers are split between two close answers (e.g., 45% High, 45% Medium, 10% low)	Minor to moderate concerns about the extent to which the underlying literature is consistent with the key statement; You feel reasonably sure there is good evidence upon which to base the conclusions drawn; Multiple sources provide an answer to the question; At least some of them address the issue directly; there are only a few sources with methodological concerns or the concerns are minor
Low	Moderate to serious concerns about the extent to which the underlying literature is consistent with the key statement; This could be assessed by number cut-offs but also requires judgement. For example, if sources are evenly split between the categories with no clear pattern (e.g., 33% High, 33% medium, 33% low); Or categories are split bimodally (e.g., 45% High, 10% medium, 45% low);	Moderate to serious concerns about the extent to which the underlying literature is consistent with the key statement; You are not entirely certain that the evidence upon which conclusions are based is solid; Only a few sources address this topic; They may not address the topic directly, or they may have methodological concerns (either concerns are frequent or severe or both)

Table 2.13: Criteria that can be used inform allocation of confidence. Based on Berrang-Ford et al. (2021).

If sufficient quantitative/probabilistic information exists, then a statistical likelihood will be provided. Table 2.14 defines the likelihood language and the corresponding statistical level.

Likelihood Language	Statistical Level
Virtually certain	99-100% probability
Very likely	90-100% probability
Likely	66-100% probability
About as likely as not	33-66% probability
Unlikely	0-33% probability
Very unlikely	0-10% probability
Exceptionally unlikely	0-1% probability

Table 2.14: Likelihood scale from Mastrandrea et al. 2011.

2.2 Stage 1: Identification and Prioritisation of Climate Risks and Opportunities

Overview

Stage 1 addresses two main questions: *How could Ireland be affected by climate change?* and *What could the consequence of these risks be?* Stage 1 involves a qualitative analysis of how Ireland is already and could be affected by future climate change to develop a preliminary understanding of the extent and relative consequence of climate risks and opportunities for Ireland. The Stage 1 qualitative analysis will be informed by literature review and stakeholder consultation (interviews and workshops) with the outputs comprising a climate risk register, consisting of climate risk statements categorised across seven systems in line with the European Union Climate Change Risk Assessment.

Task 1: Risk Identification

A review of the existing evidence base (i.e., Local Authority Climate Action Plans, Sectoral Adaptation Plans, academic literature, reports, climate projections, and data) will be undertaken to identify current and potential future risks and opportunities for relevant climate hazards (Section 2.1.7). Identified risks will focus on the elements and sub-elements at risk (Section 2.1.2) and be described using the risk statement logic (Table 2.15). Climate risk statements will detail direct, cascading, and independent risks where feasible with risk statements accounting for hazards, exposure, vulnerability. Each risk will be assigned a level of consequence for current and future time horizons (Section 2.1.5) under a high-emissions scenario (Section 2.1.6). Stage 1 will not consider adaptation; therefore, risks will be rated assuming no adaptation in place. Identified opportunities will be described following the risk statement logic as far as reasonably possible. The consequence of identified opportunities will be qualitatively assessed.

Logic	Information	Example	Information Source
A receptor…	Element/Sub-element at Risk	Buildings	Elements at risk (Table 2.4)
…and is impacted by	Hazard (pre-set list)	River Flooding	Hazards (Table 2.6)
The risk could happen in…	Time horizons (pre-set list)	Currently, medium term, and long term	Timeframes (Table 2.5) Climate Projections Literature Review
…and applies to the following regions	National or regions (pre-set list)	All of Ireland	Spatial regions (Table 2.7) Climate Projections Literature Review
The risk has been rated as…	Consequence criteria	High	Consequence Criteria (Table 2.8) Literature Review
If this risk occurred, it could have the following consequences…	Description (free-text)	Damage to buildings	Literature Review Stakeholder Engagement
As shown by the following case study…	Case study (free text)	Heavy rainfall from Storm Babet result in ~100 homes flooded in Midleton causing extensive damage to buildings and contents.	Literature Review Stakeholder Engagement

Table 2.15: The logic for describing risks. Example provided is indicative. Based on the NZ CCRA (Ministry for the Environment, 2020).

Task 2: Confidence

A level of confidence will also be assigned to each of the risk statements, based upon confidence in the hazard and assessment and potential magnitude of consequence outlined in Sections 2.1.10. and 2.1.11, respectively.

Task 3: Review of Climate Risk Register

The risks statements will be reviewed by stakeholders via an online survey to review, augment, and refine the initial risk and opportunity statements. Once reviewed, the risk and opportunity statements will be consolidated to the element at risk level, duplicates removed, and to align risks to the relevant systems (Section 2.1.2). An in-person stakeholder workshop will be then held to review the consolidated and refined risk and opportunity statements and to review and refine the magnitude of consequence for each identified risk.

Output

The output of Stage 1 will be a national climate risk register for Ireland. Risks with a potential for magnitude of consequence of Moderate or above will be taken to Stage 2, these are termed ‘key risks’.

2.3 Stage 2: Detailed Assessment of Priority Risks and Opportunities

Overview

Stage 2 addresses the question *Where and when might risks be realised?* Stage 2 involves a semi-quantitative assessment of the key risks identified in Stage 1 and will refine the understanding of the level of exposure, vulnerability, and consequence for each of the key risks. Stage 2 is informed by the geospatial analysis and stakeholder engagement through interviews and workshops.

Task 1: Development of Impact Chains

For each of the key risks, impact chains will be developed. Impact chains provide a structured way to analyse and visualise how hazards, vulnerabilities, and exposures interact to create a particular risk (Figure 2.8). They help to demonstrate the interconnected factors, both direct and indirect and support identification of relevant data and indicators to inform hazard, exposure, and vulnerability.

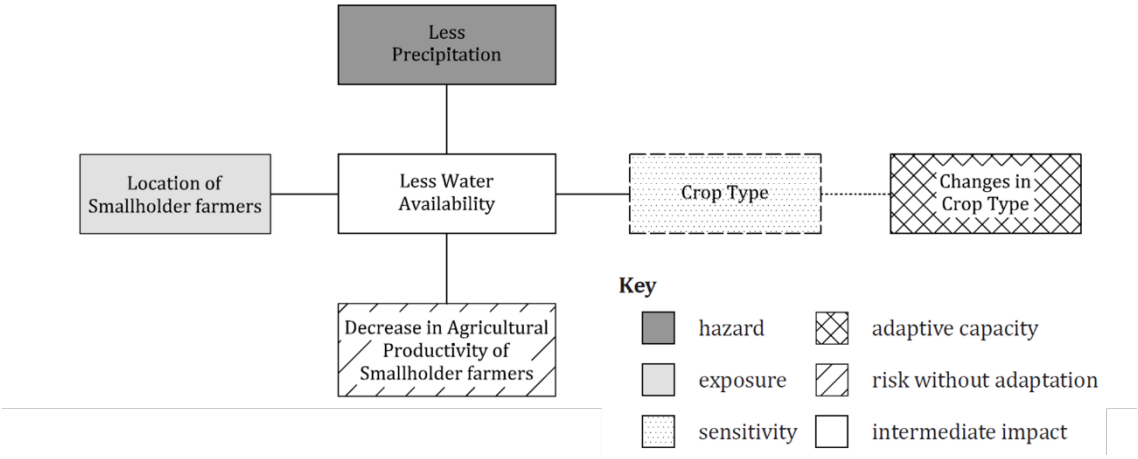

Figure 2.8: An example of a basic impact chain showing the interaction between the determinants of risk and the impact of the risk. Source: ISO 140091

To support the identification and analysis of complex risks, the impact chains will incorporate the concepts and framework described in Simpson et al. (2021) and Zscheischler et al. (2020). Simpson et al. (2021) provides a framework to describe the complex risk interactions (Section 2.1.1, Figure 2.3), such as aggregating, compounding, and cascading. Zscheischler et al. (2020) provides a typology to classify compound events into four types; preconditioned, multivariate, temporally compounding and spatially compounding. An example of a pre-conditioned event is shown in Figure 2.9. By using these frameworks and typology, a consistent terminology can be used and a 'complex risk type' assigned to relevant risks, which will be used within Stage 3 to inform decision urgency.

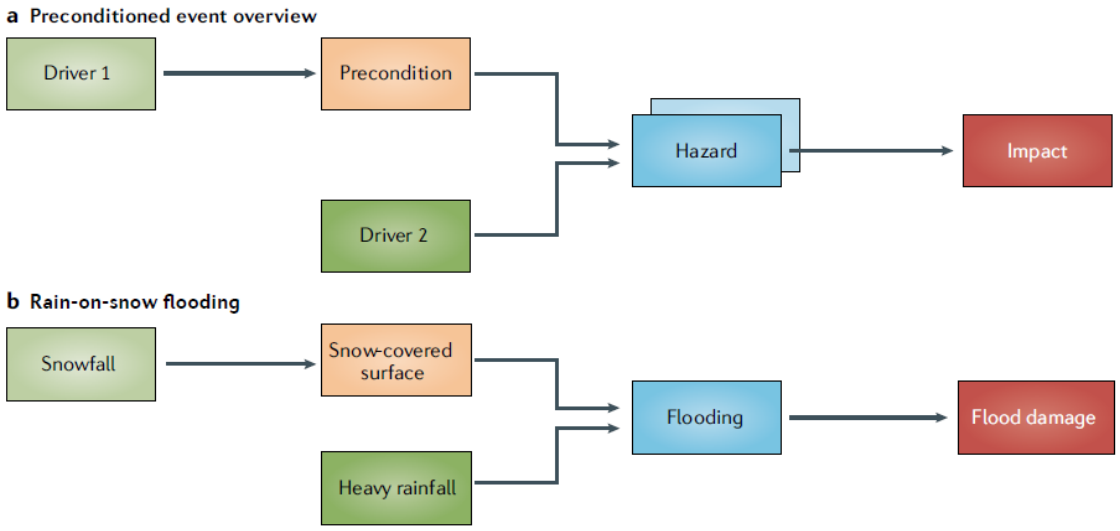

Figure 2.9: a) The key elements of a preconditioned event type b) An example of rainfall on snow resulting in flooding and flood damage (Zscheischler et al., 2020).

Task 2: Exposure and Vulnerability Assessment

Using the impact chains, the relevant hazard, exposure, and vulnerability datasets (spatial and non-spatial) will be sourced to inform and assess levels of exposure and vulnerability. Geospatial analysis will be undertaken combining hazard and element/asset locations to determine the national level of exposure for each of the risks with a level of exposure assigned following the criteria in Table 2.16. The degree of exposure will be determined for RCP8.5 and RCP4.5 scenarios (Section 2.1.6). For each of the risks, a level of vulnerability will be assigned informed by existing information and stakeholder engagement. In-person stakeholder workshops will be held to validate both the exposure and vulnerability classification.

Task 3: Refine Magnitude of Consequence and Confidence

Given the additional information provided by the exposure and vulnerability assessment, the level of consequence of each risk will be reviewed and, if necessary, revised informed by stakeholder consultation.

Level	Exposure	Vulnerability
Extreme (4)	The majority (>75%) of the element at risk is exposed to the hazard.	Extremely likely to be adversely affected, because the 'element at risk' is highly sensitive to a given hazard and has a low capacity to adapt.
High (3)	A high proportion (50–70%) of the element at risk is exposed to the hazard.	Highly likely to be adversely affected, because the 'element at risk' is highly sensitive to a given hazard and has a low capacity to adapt.
Moderate (2)	Up to half (25–50%) of the element at risk is exposed to the hazard.	Moderately likely to be adversely affected, because the 'element at risk' is moderately sensitive to a given hazard and has a low or moderate capacity to adapt.
Low (1)	A small proportion (5–25%) of the element at risk is exposed to the hazard.	Low likelihood of being adversely affected, because the 'element at risk' has low sensitivity to a given hazard and a high capacity to adapt.

Table 2.16: The exposure and vulnerability criteria. Based on the NZ CCRA (Ministry for the Environment, 2020).

Output

The output of Stage 2 will be a national climate risk register with revised magnitudes of consequence. Risks with a potential for magnitude of consequence of Moderate or above will be taken to Stage 3.

2.4 Stage 3: Adaptation and Decision Urgency

Stage 3 addresses the questions *What is the management status of current and future risks?* and *What is the urgency of action?* Stage 3 is a qualitative

assessment of the current and planned adaptation responses and the short-term (within the next five years) decision urgency required to manage each of the key risks to an acceptable level. Stage 3 is informed by existing information and stakeholder consultation through interviews and workshops.

Task 1: Review Current and Planned Adaptation Action

As part of this methodology, existing information will be reviewed, and relevant stakeholders interviewed to establish the current and future management levels of each of the key risks. To further inform the status of current and planned and potential adaptation actions, the concept of 'Risk Bowties' will be applied (IEC/ISO 31010:2019). Risk Bowties were developed as a practical tool to allow better understanding of how risks should be managed, overseen and reviewed. The strength of the Risk Bowtie is that it provides a visual synthesis of the key drivers of the problem and potential solutions (Winder et al., 2021). Using a Risk Bowtie approach in tandem with the asset management definition of resilience as '*the capacity of built assets and infrastructure to endure acute shocks and chronic stresses while successfully adapting to long term changes*' adds a layer of analysis to understanding and measuring resilience in the context of climate change.

The Risk Bowties will be used to analyse and demonstrate causal relationships identified within the impact chains developed in Stage 2. As part of Stage 3, Risk Bowties will be used to classify the actions that are currently in place or planned as both 'proactive' or 'reactive' actions (Figure 2.10). These adaptations can be analysed to see the timing of the action, whether they are currently in place or planned, or whether new or novel solutions would be required to reduce the risks identified.

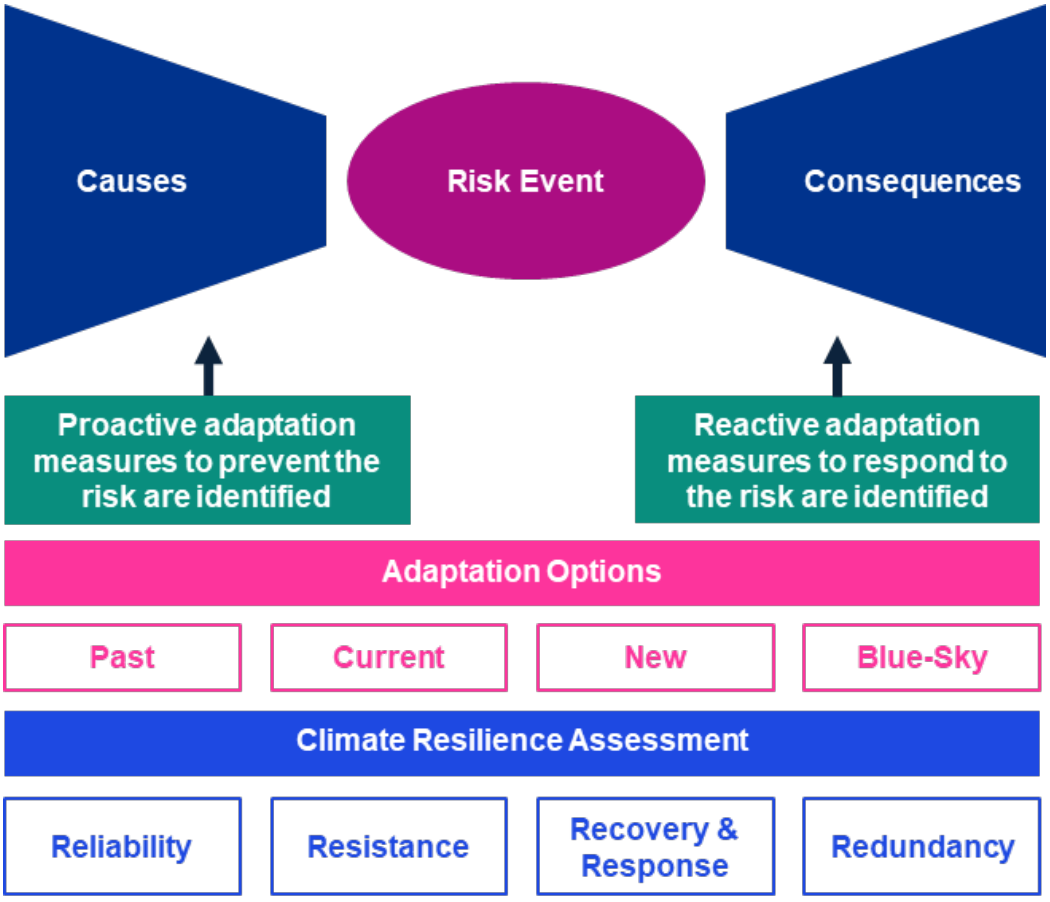

Figure 2.10: Risk Bowtie Framework diagram with proactive and reactive measures identified.

The current and planned adaptation actions can also be classified from a resilience perspective using the following categories:

- **Reliability** and **Resistance** focusing on understanding the health of the assets or climate event location.
- **Response** and **Recovery** focuses on the ability to return the system back into full operation, reducing the duration of the climate event.
- **Redundancy** focuses on the ability to continue to supply and operate through other systems in the event of a climate risk.

Through this information review and analysis an understanding of the current management level of each risk will be identified and any adaptation gaps that may exist.

Task 2: Decision Urgency

The NCCRA uses decision urgency ratings in Stage 3 to identify the need for adaptation decision-making. Urgency is defined as "*a measure of the degree to which further action is needed in the next five years to reduce a risk or realise an opportunity from climate change*" (Committee on Climate Change, 2022). There are four levels of urgency described in Figure 2.11, and informed by Task 1 and stakeholder engagement, a Decision Urgency profile will be developed for each risk. It should be noted that it is not in the scope of the NCCRA to recommend or suggest the adaptation actions that should or could be taken to reduce the identified risk.

Urgency Criteria

More Action Needed	New, stronger or different Government action, whether policies, implementation activities, capacity building or enabling environment for adaptation – over and above those already planned – are beneficial in the next five years to reduce climate risks or take advantage of opportunities. This will include different responses according to the nature of the risks and the type of adaptation: • Addressing current and near-term risks or opportunities with low and no regret options (implementing activities or building capacity). • Integrating climate change in near-term decisions with a long lifetime or lock-in. • Early adaptation for decisions with long lead-times or where early planning is needed as part of adaptive management.
Further investigation	On the basis of available information, it is not known if more action is needed or not. More evidence is urgently needed to fill significant gaps or reduce the uncertainty in the current level of understanding in order to assess the need for additional action.
Sustain Current Action	Current or planned levels of activity, are appropriate, but continued implementation of these policies and plans is needed to ensure that the risk continues to be managed in the future.

Watching Brief	The evidence in these areas should be kept under review, with continuous monitoring of risk levels and adaptation activity (or the potential for opportunities and adaptation) so that further action can be taken if necessary.

Figure 2.11: The criteria to assign urgency to each risk (Committee on Climate Change, 2022).

Output

The output of Stage 3 will be a national climate risk register consisting of national risks and opportunities with each risk consisting of a magnitude of consequence for each future time horizon, the decision urgency required to manage each of the risks to an acceptable level (Figure 2.12), a level of confidence for the risk, and where appropriate, risk owners. The risks can be prioritised based on these two criteria.

Risk	Ratings		
N1 Risks to coastal ecosystems, including the intertidal zone, estuaries, dunes, coastal lakes and wetlands, due to ongoing sea-level rise and extreme weather events.	**Urgency**		78
	Consequence	Now	Min
		2050	Mod
		2100	Major

Figure 2.12: An example of the highest nature-related climate risk for New Zealand showing the urgency score and the magnitude of consequence for the three-time horizons (Ministry for the Environment, 2020).

3 Stakeholder Engagement

Stakeholder engagement is a critical element of the NCCRA to build an appropriate evidence base to inform the identification and assessment of risks. Stakeholder engagement in the NCCRA is based on four key principles:

- **Inform:** This approach underpins all stakeholder engagement activities. It is the foundational step which seeks to commence information and knowledge sharing so that all stakeholders are aware of and understand the project objectives, as well as the expectations of their participation during the project. This stage is critical in achieving stakeholder buy in.
- **Consult:** This approach seeks to gather initial feedback on emerging project material and to ensure that a baseline understanding of critical views and perspectives is established.
- **Involve:** This approach seeks to collaboratively build knowledge and demonstrate how this deeper level of engagement influences the shape and trajectory of the project outcomes.
- **Develop:** In developing the finalised project outputs, this approach aims to ensure that stakeholders feel that their views have been adequately captured and enables final decision making and validation.

Broadly, the stakeholder engagement process for the NCCRA has been designed to incorporate four distinct phases, as follows:

- Method Development Engagement
- Awareness Building
- Risk Assessment Engagement
  a) Identification and prioritisation of climate risks and opportunities
  b) Detailed assessment of priority risks and opportunities
  c) The status of adaptation and urgency of adaptation action

- Final Report Engagement

A stakeholder engagement plan has been developed to support the stakeholder engagement process. This document will set the framework and principles for engaging with stakeholders at each stage of the project. It identifies and categorises key government departments, agencies, partners, and stakeholders relevant to the NCCRA – and details the specific engagement activities to be pursued. It is important to note that the stakeholder engagement plan is considered a living document and will be iteratively updated through NCCRA development. A summary of the stakeholder identification process and engagement activities are outlined below.

3.1 Identification of Key Stakeholders

Based on existing information and a review of literature, key stakeholders to be engaged across the NCCRA process have been identified through a comprehensive stakeholder mapping process. This mapping exercise sought to provide a logical and verifiable approach to the structure of the engagement processes – and the appropriate grouping or categorisation of key stakeholders for this purpose.

This initial mapping exercise considered all relevant sectors and sub-sectors in Ireland, including agencies, partners, and organisations directly involved in climate change risk mitigation and adaptation. The exercise has been informed in the first instance by the assessments carried out under Ireland's the NAF (2018). Specifically, the consultation process undertaken in the development of the Sectoral Adaptation Plans (SAPs) was reviewed in detailed and key stakeholders engaged as part of that process were identified. Thereafter a comprehensive gap analysis was performed to ensure that all relevant sectors were represented – and to facilitate more detailed evaluation of cascading and transboundary risks.

Stakeholders were identified from government bodies or agencies, research groups, private sector interests, and community organisations, who have insight into the impacts of climate change on a particular sector, region, or industry. These stakeholders were categorised into three groups:

- **Steering Group:** The Project Steering Committee will be central to guiding the high-level structure as well as strategic direction of the NCCRA - inclusive of method development.
- **Expert Working Group**: The expert working group will consists of the Climate/Socio-Economic Working Group to provide expert scientific and policy advice and insights related to the identification of relevant climate, environmental and socio-economic information and data and associated considerations. The Thematic Working Group which will provide expert scientific and policy advice and insights related to the identification of appropriate thematic areas and associated elements at risk, the determination of key criteria that underpin the NCCRA framework and the operationalisation of this framework through the delivery of the three phases of the NCCRA.
- **Wider Stakeholders**: The wider stakeholders will be kept up to date and informed of the NCCRA activities to ensure buy-in and understanding of the NCCRA outputs and outcomes. The wider stakeholders on listed in the Appendix.

3.2 Method Engagement

The objective of this sub-task is to ensure that relevant methodological considerations are assessed in determining the best approach to the NCCRA. The method engagement activities consist of workshops and document review and feedback. The activities and target stakeholder groups are outlined in further detail below in Table 3.1.

Activities	Stakeholder Group(s)	Indicative Timeframe	Outputs
Two online workshops: Technical workshop Thematic Workshop	Expert Working Groups	Mid to end February	Minutes of workshops and summary consultation report
Feedback on First Order Draft (FOD)	Steering Group	Mid-March	Comments on First Order Draft document

Table 3.1: Method engagement plan

3.3 Awareness Building

The overarching aim of awareness building is to introduce wider key stakeholders to the project - in terms of the intention to develop a NCCRA; the three assessment stages; and the role of stakeholders across the process. This will be a crucial step to ensure stakeholder buy in and address any initial queries prior to the commencement of the risk assessment exercises. As shown in Table 3.2, as part of the inform approach to stakeholder engagement, awareness of the NCCRA will be built amongst stakeholders through a range of activities.

Activities	Stakeholder Group(s)	Indicative Timeframe	Outputs
1) Hold a webinar to provide a high-level introduction to the NCCRA and to ensure that stakeholders are clear on the purpose and rationale of the exercise – and their expected role within	• Steering Group • Expert Working Groups • Wider Stakeholders	Early to mid-March 2024	Webinar recording which can be circulated to other stakeholders

Activities	Stakeholder Group(s)	Indicative Timeframe	Outputs
this. A Q&A session will be facilitated at the end of the webinar. This webinar will be held in mid to late March via Zoom/ Teams and will be approximately 2 hours long. The webinar presentation will be recorded so that stakeholders who are unable to attend can view the presentation. The Q&A session will not be recorded. Questions and responses will be recorded, though they will not be attributed to any individual contributors.			
2) Develop a stakeholder memo / pre-consultation package setting out the proposed methodological approach to the risk assessment stage. a. This pre-consultation pack will detail the role of stakeholders	• Steering Group • Expert Working Groups • Wider Stakeholders	Early to mid-March 2024	Pre-consultation pack which can be circulated to

Activities	Stakeholder Group(s)	Indicative Timeframe	Outputs
throughout the project, providing stakeholders clarity on the expectations and extent of their involvement. The pack will also outline the purpose, rationale, and method to develop the NCCRA as clearly as possible, so that all stakeholders gain a solid understanding of the project.			other stakeholders.

Table 3.2: Awareness building stakeholder engagement plan

3.4 Risk Assessment Engagement

As part the three stages of the NCCRA, there will be various engagement activities for each stage of the risk assessment. These activities are outlined in more detail below.

3.4.1 Stage 1: Identification and Prioritisation of Climate Risks and Opportunities

The objective of this stage is to broadly identify the climate change risks and opportunities to be prioritised for Stage 2. As part of the consult and involve approaches, stakeholders will be asked to identify a long list of climate risk and opportunities, which they will then work to finalise. Table 3.3 outlines how this objective will be achieved.

Activities	Stakeholder Group(s)	Indicative Timeframe	Outputs
The development and circulation of an online survey amongst stakeholders to develop an initial long list of climate risks and opportunities	• Expert Working Groups • Wider Stakeholders	End April to End May	Detailed survey analysis
An in-person sectoral workshop to validate and finalise the long list. The workshop will be carefully structured around an agenda developed in consultation with the EPA. The workshop will comprise of a plenary session and then discursive breakout sessions, facilitated by KPMG.	• Expert Working Groups	Early June	Meeting minutes and summary consultation findings.

Table 3.3: Identification and prioritisation of climate risks and opportunities stakeholder engagement plan

3.4.2 Stage 2: Detailed Assessment of Priority Risks and Opportunities

The objective of this stage is to undertake more detailed assessment of the priority risks and opportunities. Table 3.4 outlines how this will be achieved.

Activities	Stakeholder Group(s)	Indicative Timeframe	Outputs
Series of in-**person thematic workshops** • Comprising of a plenary session to introduce participants to the NCCRA followed by sectoral breakout activities that will ask participants to focus on priority risks for their sectors with the aim of developing information on exposure and vulnerability,	• Wider Stakeholders	July to September	Meeting minutes and summary consultation findings.

cross-sectoral between risks, and information gaps			
Cross-sector participation in **online focus groups** • Based on the identified cross-sectoral risks identified, multiple sectors will be brought together to explore and evaluate potential cross-cutting and cascading risks via online focus groups to allow for more targeted discussion.	• Expert Working Groups	September – October	Meeting minutes and summary consultation findings.

Table 3.4: Detailed assessment of priority risks and opportunities and opportunities stakeholder engagement plan

3.4.3 Stage 3: Adaptation and Decision Urgency

The objective of this stage is to review current and planned responses to the key risks and opportunities to assess action and decision urgency. A summary version of the revised list of priority national and sub-national risks and opportunities for each sector will be circulated to all stakeholders to inform a subsequent assessment of adaptation action and decision urgency. Specifically, sectoral stakeholders and relevant experts will be consulted to identify any adaptation actions planned or underway, whether risks would benefit from short term action, whether adaption 'lock-ins' [2] can be avoided, and adaptation urgency. Table 3.5 outlines the form this engagement will take.

Activities	Stakeholder Group(s)	Indicative Timeline	Outputs
A targeted **online survey** to gauge views on adaptation responses	• Expert Working Groups • Wider Stakeholders	September/ October	Detailed Survey Analysis

[2] A situation in which the future development of a system, including infrastructure, technologies, investments, institutions, and behavioural norms, is determined or constrained ('locked in') by historical developments (IPCC, 2023: Annex 1).

Targeted **online focus groups** which will present survey findings	• Expert Working Groups	October	Meeting minutes and summary consultation findings.
Semi-structured interviews with relevant experts	• TBC	October/ November	Meeting minutes and summary consultation findings.

Table 3.5: Adaptation and urgency of adaptation action stakeholder engagement plan

All four approaches to stakeholder engagement underpin these activities, as stakeholders share knowledge on adaptation actions and urgency based on the information provided during consultation.

3.5 Final Report Engagement

As part of the finalisation of the NCCRA, four main reports will be produced:

- Main report: this report identifies climate change risks and opportunities. It outlines the most urgent risks and provides an overview of other priority risks and opportunities.
- Technical report: this report details the evidence base which informs the risk assessment and makes up the current knowledge of climate change risks in Ireland.
- Summary report: this report will be a succinct document which presents the policy-relevant aspects of the risk assessment in non-technical and accessible language.
- Consultation report: this report will be a concise document which summarises the findings gathered from the various stakeholder engagement activities of the project.

These reports will be produced with significant elements of stakeholder input, reflecting the importance of the develop approach to engagement in finalised project outputs. A draft of each report will be shared with key stakeholders. Other stakeholder feedback will be gathered through an online survey during November and December. Online and in-person workshops will also be held to provide further opportunity for stakeholders to be involved in the finalisation of the four reports. As shown in Table 3.6, these workshops will be held over December 2024 and January 2025.

Activities	Stakeholder Group(s)	Indicative Timeframe	Outputs
Draft versions of each document will be shared with stakeholders for review.	• Steering Group • Expert Working Groups	November 2024 to January 2025	Finalised four main reports with stakeholder input.
Stakeholder feedback will be gathered through a final and concise **survey.**	• Expert Working Groups		
Online and in-person **meetings** will be held to support the final drafting of reports.	• Steering Group		

Table 3.6: Finalisation of report stakeholder engagement plan.

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Glossary

Key Term	Definition
Adaptation	In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2023: Annex 1).
Adaptive Capacity	The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (adapted from MA, 2005) (IPCC, 2022: Annex II).
Assets	'Things of value' that may be exposed or vulnerable to a hazard or risk. Physical, environmental, cultural, financial or economic element that has tangible, intrinsic or spiritual value.
Baseline	A time period of interest, or a period over which some relevant statistics are calculated (IPCC, 2022, Annex II).
Biodiversity	Biodiversity or biological diversity means the variability among living organisms from all sources including, among other things, terrestrial, marine and other aquatic ecosystems, and the ecological

Key Term	Definition
	complexes of which they are part; this includes diversity within species, between species and of ecosystems (IPCC, 2023: Annex 1).
Cascading effects (of climate change)	Cascading impacts from extreme weather/climate events occur when an extreme hazard generates a sequence of secondary events in natural and human systems that result in physical, natural, social or economic disruption, whereby the resulting impact is significantly larger than the initial impact. Cascading impacts are complex and multi-dimensional and are associated more with the magnitude of vulnerability than with that of the hazard (IPCC, 2023: Annex 1).
Climate	Climate in a narrow sense is usually defined as the average weather, or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization (WMO). The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system (IPCC, 2023: Annex 1).

Key Term	Definition
Climate Change	A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/ or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2023: Annex 1).
Climate Projections	A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of the cryosphere, the lithosphere and the biosphere and the interactions between them. The climate system evolves in time under the influence of its own internal dynamics and because of external forcings such as volcanic eruptions, solar variations and anthropogenic forcings such as the changing composition of the atmosphere and land-use change (IPCC, 2018: Annex I).
Co-benefits	A positive effect that a policy or measure aimed at one objective has on another objective, thereby increasing the total benefit to society or the environment. Co-benefits are also referred to as ancillary benefits (IPCC, 2022: Annex II).

Key Term	Definition
Community	A community may be a geographical location (community of place), a community of similar interest (community of practice) or a community of affiliation or identity (such as industry).
Compound hazards and stressors	Combined occurrences of multiple hazards and stressors (i.e., cumulative hazards) that will become more significant in the future as adaptation thresholds are reached, for example, for a low-lying coastal area, a persistent wet season (high groundwater, reduced field capacity) is followed by a coastal storm amplified by sea-level rise coincident with intense rainfall, leading to compound flooding impacts.
Confidence	The robustness of a finding based on the type, amount, quality, and consistency of evidence (e.g., mechanistic understanding, theory, data, models, expert judgement) and on the degree of agreement across multiple lines of evidence. In this report, confidence is expressed qualitatively (Mastrandrea et al., 2010).
Consequence	The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather/climate events), exposure, and vulnerability. Impacts generally refer to effects on lives, livelihoods, health and well-being, ecosystems

Key Term	Definition
	and species, economic, social and cultural assets, services (including ecosystem services) and infrastructure (IPCC, 2022, Annex II).
Disaster	Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery (IPCC, 2018: Annex I).
Driver	Any natural or human-induced factor that directly or indirectly causes a change in a system (adapted from MA, 2005) (IPCC, 2022: Annex II).
Emissions (Anthropogenic)	Emissions of greenhouse gases (GHGs), precursors of GHGs and aerosols caused by human activities. These activities include the burning of fossil fuels, deforestation, land use and land-use changes (LULUC), livestock production, fertilisation, waste management and industrial processes (IPCC, 2023: Annex 1).
Exposure	The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or

Key Term	Definition
	cultural assets in places and settings that could be adversely affected (IPCC, 2023: Annex 1).
Extreme weather event	The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as 'climate extremes (IPCC, 2023: Annex 1).
Frequency	The number or rate of occurrences of hazards, usually over a particular period (NZ CCRA Framework, 2019).
Greenhouse gas	Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of radiation emitted by the Earth's surface, by the atmosphere itself, and by clouds. This property causes the greenhouse effect (IPCC, 2023: Annex 1).
Hazard	The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources (IPCC, 2023: Annex 1).

Key Term	Definition
Heatwave	A period of abnormally hot weather, often defined with reference to a relative temperature threshold, lasting from two days to months. Heatwaves and warm spells have various and, in some cases, overlapping definitions (IPCC, 2023: Annex 1).
Impacts (consequences, outcomes)	The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather/climate events), exposure, and vulnerability. Impacts generally refer to effects on lives, livelihoods, health and wellbeing, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Impacts may be referred to as consequences or outcomes and can be adverse or beneficial (IPCC, 2023: Annex 1).
Impact chain	Impact chains are conceptual models describing climate impact as cause-effect relationships within a socio-ecological system.
Just resilience	The concept of 'leaving no one behind' in climate change also called 'justice in adaptation' or 'just resilience', thus needs to be properly taken into account in implementing just, transformative and long-term climate adaptation to avoid maladaptive practices, redistributing risk or reinforcing existing

Key Term	Definition
	inequalities, and avoid creating "winners" and "losers".
Land use	The total of arrangements, activities and inputs applied to a parcel of land. The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, conservation, and city dwelling) (IPCC, 2023: Annex 1).
Land-use change	The change from one land use category to another. Note that in some scientific literature, land-use change encompasses changes in land-use categories as well as changes in land management (IPCC, 2023: Annex 1).
Likelihood	The chance of a specific outcome occurring, where this might be estimated probabilistically. Likelihood is expressed in this report using a standard terminology (Mastrandrea et al., 2010).
Lock in	A situation in which the future development of a system, including infrastructure, technologies, investments, institutions, and behavioural norms, is determined or constrained ('locked in') by historical developments (IPCC, 2023: Annex 1).
Mitigation	A human intervention to reduce emissions or enhance the sinks of greenhouse gases (IPCC, 2023: Annex 1).

Key Term	Definition
Percentile	A partition value in a population distribution that a given percentage of the data values are below or equal to. The 50th percentile corresponds to the median of the population. Percentiles are often used to estimate the extremes of a distribution. For example, the 90th (10th) percentile may be used to refer to the threshold for the upper (lower) extremes (IPCC, 2023: Annex 1).
Representative concentration pathway	Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008). The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes the fact that not only the long-term concentration levels, but also the trajectory taken over time to reach that outcome are of interest (Moss et al., 2010). RCPs were used to develop climate projections in CMIP5 (IPCC, 2023: Annex 1).
Residual risk	The risk related to climate change impacts that remains following adaptation and mitigation efforts. Adaptation actions can redistribute risk and impacts, with increased risk and impacts in some areas

Key Term	Definition
	or populations, and decreased risk and impacts in others (IPCC, 2022: Annex II).
Resilience	The capacity of interconnected social, economic, and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (IPCC, 2023: Annex 1).
Risk	The potential for adverse consequences for human or ecological systems, recognizing the diversity of values and objectives associated with such systems (IPCC, 2023: Annex 1).
Risk assessment	The qualitative and/or quantitative scientific estimation of risks (IPCC, 2022: Annex II:).
Shock	Deviations from normal environmental patterns in the form of droughts, floods, heat waves, or other extreme events that have been exacerbated by climate change
Stress	Environmental stress denotes both human and naturally induced pressure on the environment. As a subset of this, stress caused by climate change refers to negative environmental impacts caused by gradual changes in atmospheric conditions.

Key Term	Definition
Stressor (climate)	Events and trends, often not climate-related, that have an important effect on the system exposed and can increase vulnerability to climate-related risk (IPCC, 2022: Annex II).
System	A set of things working together as parts of an interconnected network and/or a complex whole (NZ CCRA Framework, 2019).
Uncertainty	A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, incomplete understanding of critical processes, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgement 2253 Glossary Annex VII AVII of a team of experts) (IPCC, 2022: Annex II).
Value domain	A group of values, assets and systems that may be at risk from climate change-related hazards, or could benefit from them (NZ CCRA Framework, 2019)
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of

Key Term	Definition
	concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC, 2023: Annex 1).
Wellbeing	A state of existence that fulfils various human needs, including material living conditions and quality of life, as well as the ability to pursue one's goals, to thrive and to feel satisfied with one's life. Ecosystem well-being refers to the ability of ecosystems to maintain their diversity and quality (IPCC, 2023: Annex 1).

Acronyms

Acronym	Definition
AR5	Fifth Assessment Report
AR6	Sixth Assessment Report
CCRA	Climate Change Risk Assessment
CFRAM	Catchment-based Flood Risk Assessment and Management
CSO	Central Statistics Office
DCCEEW	Department of Climate Change, Energy, the Environment, and Water
DECC	Department of the Environment, Climate and Communications
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
ESRI	Economic and Social Research Institute
EU	European Union
EUCRA	European Climate Risk Assessment
GHG	Greenhouse Gas Emissions
GSI	Geological Survey Ireland
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LACAP	Local Authority Climate Acton Plan
NAF	National Adaptation Framework

Acronym	Definition
NCCRA	National Climate Change Risk Assessment
NFCS	National Framework for Climate Services
NUTS	Nomenclature of Territorial Units for Statistics
NZ	New Zealand
OPW	Office of Public Works
RCPs	Representative Concentration Pathways
SAP	Sectoral Adaptation Plans
UK	United Kingdom
UKCP18	UK Climate Projections 2018
WP	Work Package

Appendix 1: Stages of the NCCRA

Stage 1: Identification and Prioritisation of Climate Risks and Opportunities

Stage	**Identification and Prioritisation of Climate Risks and Opportunities**	
Question	How could Ireland be affected by climate change?	What could be consequence of these risks?
Method Components Used	• Climate Projections • Time Horizons • Hazards • Elements at Risk • Spatial Regions • Confidence Criteria • Risk Statements	• Magnitude of Consequence Criteria • Socioeconomic Projections • Spatial Regions • Confidence Criteria
Process	Develop risk and opportunity statements based on elements or sub-elements for current risks and future risks under a RCP8.5 scenario for medium- and long-term time horizons. If relevant, spatial regions impacted will be identified. A level of confidence applied to each risk and opportunity statement. Information recorded on data gaps.	For each risk statement, assess the magnitude of consequence across the three time-horizons. Opportunity statements are assessed qualitatively. The level of confidence applied to each risk and opportunity statement reviewed Information recorded on data gaps.
Analysis	Review of academic literature and reports to assess the changes in the hazards and the current impacts and future risks due to climate change.	Review of academic literature and reports to assess the potential consequence of identified risks.
Key Data Sources (Not exhaustive)	• TRANSLATE Climate Projections • Nolan and Flanagan Climate Projections • IPPC AR6 • OPW CFRAM • Irish Climate Change Assessment • Sectoral Adaptation Plans • Local Authority Climate Action Plans • EPA Research Reports • National Risk Assessment	• Irish Climate Change Assessment • Sectoral Adaptation Plans • Local Authority Climate Action Plans • EPA Research Reports • National Risk Assessment • IPPC AR6 • EUCRA • Copernicus Climate Data Store • Climate-ADAPT

Stakeholder Engagement	Consultation with experts and stakeholders via online survey and thematic in-person workshops. Information developed during the analysis will be provided to inform stakeholder engagement activities.	
Output	A preliminary list of risk and opportunity statements with an associated confidence level.	A national climate risk register consisting of risk statements with an associated magnitude of consequence and confidence level. Key risks (those with a magnitude of consequence of Moderate or higher) and all opportunities will be taken forward to Stage 2.

Table A.0.1: An overview of the Stage 1 process.

Stage 2: Assessment of Risks and Opportunities

Stage	**Assessment of Risks and Opportunities**
Question	Where and when might risks be realised?
Method Components Used	• Climate Projections • Time Horizons • Hazards • Elements at Risk • Spatial Regions • Confidence Criteria • Magnitude of consequence Criteria • Exposure and Vulnerability Criteria
Process	Develop impact chains for the key risks showing the hazard, exposure, and vulnerability determinants of each risk, and identifying any complex risk components. Use the impact chains to inform a geospatial assessment of exposure and vulnerability. The level of exposure and vulnerability will be established for each risk and the magnitude of consequence and confidence levels revised considering RCP8.5 and RCP4.5.
Analysis	Review of academic literature and reports to develop impact chains and complex risk, followed by geospatial analysis of exposure and vulnerability of key risks where sufficient data allows.
Key Data Sources (Not exhaustive)	• TRANSLATE Climate Projections • Nolan and Flanagan Climate Projections • OPW Flood Maps • OPW Areas of Benefit • UKCP18 • GSI Groundwater Flood • CSO Census Data • Tailte Éireann (Prime2) • National Land Cover Map
Stakeholder Engagement	Consultation with experts and stakeholders via thematic in-person workshops and cross-thematic online workshops. Information developed during the analysis will be provided to inform stakeholder engagement activities.
Output	A national risk and opportunity register refined with additional information on exposure and vulnerability. Key risks (those with a magnitude of consequence of Moderate or higher) and nationally significant opportunities taken to Stage 3.

Table A.0.2: An overview of the Stage 2 process

Stage 3: Adaptation and Decision Urgency

Stage	**Adaptation and Decision Urgency**	
Question	What is the management status of current and future risks? and	What is the urgency of action?
Method Components Used	• Risk Bowties	• Urgency Criteria
Process	Establish the current and future management levels of each of the key risks. To further inform the status of current and planned and potential adaptation actions, the concept of 'Risk Bowties' will be applied.	For each risk statement, assess the level of decision urgency through the development of a 'urgency profile.
Analysis	Existing information reviewed, and relevant stakeholders consulted.	Existing information reviewed, and relevant stakeholders consulted.
Key Data Sources (Not exhaustive)	• Irish Climate Change Assessment • Sectoral Adaptation Plans • Local Authority Climate Action Plans • National Adaptation Framework	• Irish Climate Change Assessment • Sectoral Adaptation Plans • Local Authority Climate Action Plans • National Adaptation Framework
Stakeholder Engagement	Consultation with experts and stakeholders via online survey, online focus groups and semi-structured interviews.	
Output	For each risk, an understanding of the adaptation measures currently in place and planned.	A national climate risk register consisting of national risks and opportunities with each risk consisting of a magnitude of consequence for each future time horizon and the decision urgency required to manage the each of the risks to an acceptable level.

Table A.0.3: An overview of the Stage 3 process.

Appendix 2: Stakeholder Engagement

Initial Identification of Wider Stakeholders

Wider Stakeholder Organisations		
All Island Climate Biodiversity Research Network	An Foram Uisce	An Taisce
Archaeological Survey Ireland	Association of Architectural Conservation Officers	Biodiversity Working Group
Birdwatch Ireland	Blue Shield Ireland	Bord Bia
Bord Iascaigh Mhara	Bord na Mona	Bus Eireann
County and City Management Association (CCMA)	Chartered Institute of Ecology and Environmental Management	CIE
Climate Change Advisory Council	Coillte	Construction Industry Federation Ireland
Council of National Cultural Institutions	DAA	Department of Agriculture, Food, and the Marine
Department of Defence	Department of Education	Department of Finance
Department of Housing, Local Government, and Heritage	Department of Public Expenditure, NDP Delivery, and Reform	Department of Rural and Community Development
Department of Social Protection	Discovery Programme	Dublin Bus
Dublin Port Company	EirGrid	Electricity Association of Ireland
Engineers Ireland	Enterprise Ireland	Environmental Pillar
Environmental Sustainability Committee	ESB Generation and Trading	ESB Networks
Failte Ireland	Food Safety Authority of Ireland	Gas Networks Ireland
Heritage Council	Heritage Officer Network	HSA
HSE	Iarnrod Eireann	IBEC

Irish Creamery Milk Suppliers Association	Inshore Fisheries Forum	Institute of Archaeologists Ireland
Institute of Conservator-Restorers in Ireland	Institute of Public Health	Irish Aviation Authority
Irish Georgian Society	Irish Planning Institute	Irish Rural Link
Irish Solar Energy	Irish Wind Energy Association	Irish Universities Association
LAWPRO	Local Authorities	MAREI
Medical Health Council	National Biodiversity Data Centre	National Biodiversity Forum
National Botanic Gardens	National Disability Authority	National Monuments Service
National Museum of Ireland	National Monuments Service	National Standards Authority of Ireland
National Transport Authority	NPWS	Office of Emergency Planning
Port of Waterford	Rosslare Europort	Royal College of Surgeons Ireland
Royal Institute of Architects of Ireland	SEAI	SFI
Shannon Foynes Port Company	Sea Fisheries Protection Authority	Society of Irish Foresters
Sport Ireland	Telecommunications Industry Ireland	The Technological Higher Education Association
Tourism Ireland	Transport Infrastructure Ireland	Uisce Eireann
Waterways Ireland	Wind Energy Ireland	2RN

Table A.0.4: Initial Identification of Wider Stakeholders

Appendix 3: NCCRA and OPW Flooding Scenario Alignment Approach

A3.1 Introduction

For the purposes of the CFRAM Programme, the OPW adopted two indicative potential futures for flood risk assessment; the Mid-Range Future Scenario (MRFS) and the High-End Future Scenario (HEFS) (OPW, 2019). These were selected to reflect, based on information available at the time, a future in the latter part of the century that would be:

a) typical or near to the general average of the future climate projections (MRFS), and,

b) a more extreme future based on the upper end of the range of projections of future climatic conditions and the impacts such changes would have on the drivers of flood risk (HEFS).

The changes in flood-related parameters under each scenario are set out in Table A.0.5. The allowances set out in Table A.0.5 were not derived from a specific set of projections from the IPCC reports. They were, rather, based on a range of sources available at the time, including research outputs from down-scaling climate impact projections by Sweeney and Fealy (2006), the EPA Report on climate change impacts (2003), and the guidance at that time from the UK, the Flood and Coastal Defence Project Appraisal Guidance (FCDPAG3) (DEFRA, 2006).

A future timeframe is not directly assigned to the MRFS and HEFS, therefore for use within the NCCRA, the timing of the changes associated with precipitation and mean sea level within the MRFS and HEFS scenarios need to be aligned with the RCP4.5 and RCP8.5 scenarios to be consistent with the NCCRA Methodology and allow the identification of a representative flood extent data layer to be used within Stage 2 of the Risk Assessment.

The following sections outline the methodology to align the coastal and river flooding extents with the RCP4.5 and RCP8.5 scenarios for 2050 and 2100.

Parameter	Mid-Range Future Scenario	High-End Future Scenario
Extreme Rainfall Depths	+ 20%	+ 30%
Peak Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm
Land Movement	- 0.5 mm/year[1]	- 0.5 mm/year[1]
Urbanisation	No General Allowance – Review on Case-by-Case Basis	No General Allowance – Review on Case-by-Case Basis
Forestation	- 1/6 Tp[2]	- 1/3 Tp[2] + 10% SPR[3]

Table A.0.5: Allowances in Flood Parameters for the Mid-Range and High-End Future Scenarios (OPW, 2019). Note 1: Applicable to the southern part of the country only (Dublin – Galway and south of this) Note 2: Reduction in the time to peak (Tp) to allow for potential accelerated runoff that may arise as a result of drainage of afforested land. Note 3: Add 10% to the Standard Percentage Runoff (SPR) rate: This allows for temporary increased runoff rates that may arise following felling of forestry.

A3.2 Coastal Flooding

A3.2.1 Data Availability

The OPW have mapped the coastal flood extents as part of the National Coastal Flood Hazard Mapping (OPW, 2021) with national coastal flood extent and depth maps produced for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% Annual Exceedance Probabilities (AEPs) for the Present Day scenario, and for the MRFS and HEFS. The OPW have also prepared flood maps for these probabilities for a High+ End Future Scenario (H+EFS; Mean Sea Level rise of +1500mm) and a High++ End Future Scenario (H++EFS; Mean Sea Level rise of +2000mm) for coastal flooding (ICWWS: National Coastal Extreme Water-level Estimation Points (2018 Phase 1)).

A3.2.2 Alignment

The sea level rise projections for a location off the southern coast of Ireland are shown in Table A.0.6. This location shows the highest sea level rise in Ireland and therefore represents a conservative sea level rise estimate for Ireland.

Time Horizon	Sea Level Rise (metres)					
	RCP4.5			RCP8.5		
	5th	50th	95th	5th	50th	95th
2050	0.11	0.25	0.43	0.12	0.27	0.46
2100	0.31	0.62	1.09	0.45	0.81	1.40

Table A.0.6: The sea level rise projections for two climate scenarios off the coast off southern Ireland (longitude: 50, latitude: -10). Source: Fox-Kemper et al. (2021).

To align with the RCP4.5 and RCP8.5 scenarios, the 50th percentile sea level rise for these scenarios was added to the present-day flood depths, i.e., if the present day 50% AEP flood depth is 3.3 m, 0.25 m was added to the depth resulting in a total of 3.55 m for the 50% AEP flood in 2050 within an RCP4.5 scenario. The flood depths for all return periods and all OPW scenarios were then inspected to identify the closest modelled flood depth. This resulted in the identification of the most representative data layer for this sea level, i.e., for the example above, the

closest modelled flood depth was 3.54 m, which was the modelled flood depth for the present-day 5% AEP coastal flood extent. A worked example is shown in Table A.0.7.

This process was repeated for each of the 337 data points with the most frequent data layer chosen as the representative extent for the scenario and time frame combination as shown in Table A.0.8.

Point	Description	Annual Exceedance Probability							
		50%	20%	10%	5%	2%	1%	0.5%	0.1%
NE1	Present Day Flood Height (m)	3.3	3.4	3.47	3.54	3.64	3.72	3.79	3.96
	RCP4.5 2050 Flood Height (+0.25 m)	3.55	3.65	3.72	3.79	3.89	3.97	4.04	4.21
	Closest Flood Depth (m)	3.54	3.64	3.72	3.79	3.9	3.97	4.04	4.22
	AEP (Scenario)	5% (Present)	2% (Present)	1% (Present)	0.5% (Present)	20% (MRFS)	10% (MRFS)	5% (MRFS)	1% (MRFS)

Table A.0.7: Demonstration of the Annual Exceedance Probabilities (AEP) and scenario assignment approach for RCP4.5 2050 for point NE1 of the ICWWS: National Coastal Extreme Water-level Estimation Points (2018 Phase 1).

Annual Exceedance Probability	RCP4.5		RCP8.5	
	2050 (SLR: 0.25 m)	2100 (SLR: 0.62 m)	2050 (SLR: 0.27 m)	2100 (SLR: 0.81 m)
50%	5% (Present)	20% (MRFS)	5% (Present)	5% (MRFS)
20%	2% (Present)	10% (MRFS)	2% (Present)	1% (MRFS)
10%	1% (Present)	5% (MRFS)	0.5% (Present)	1% (MRFS)
5%	1% (Present)	2% (MRFS)	0.5% (Present)	20% (HEFS)
2%	20% (MRFS)	1% (MRFS)	10% (MRFS)	10% (HEFS)
1%	5% (MRFS)	0.5% (MRFS)	5% (MRFS)	5% (HEFS)
0.5%	5% (MRFS)	10% (HEFS)	5% (MRFS)	2% (HEFS)
0.1%	1% (MRFS)	5% (HEFS)	0.5% (MRFS)	0.5% (HEFS)

Table A.0.8: The representative coastal flood extents that will be used within the NCCRA for each Annual Exceedance Probabilities and future sea level under RCP4.5 and RCP8.5 scenarios.

A3.3.0 River Flooding

A3.3.1 Data Availability

The OPW have modelled river flood extents through two datasets. Firstly, the National Catchment-based Flood Risk Assessment and Management (CFRAM) data, which includes maps of river flood extent and depth for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% AEPs for the present-day and MRFS, and for the 5%, 1% and 0.1% AEPs for the HEFS, and which covers the communities identified as being at potentially significant flood risk (Table A.0.9). Secondly, the National Indicative Fluvial Mapping (NIFM) Project (OPW, 2020), under which maps has been produced for catchments greater than 5 km^2 in areas for which flood maps were not produced under the National CFRAM Programme. The NIFM project mapping includes river flood extents and depths for the 10%, 1%, and 0.1% AEPs for the present-day, MRFS and HEFS.

Annual Exceedance Probability	CFRAM			NIFM		
	Present Day	MRFS	HEFS	Present Day	MRFS	HEFS
50%	Available	Available				
20%	Available	Available				
10%	Available	Available	Available			
5%	Available	Available		Available	Available	Available
2%	Available	Available				
1%	Available	Available	Available	Available	Available	Available
0.5%	Available	Available				
0.1%	Available	Available	Available	Available	Available	Available

Table A.0.9: The data availability for the National Catchment-based Flood Risk Assessment and Management (CFRAM) and the National Indicative Fluvial Mapping (NIFM) Programmes.

A3.3.2 Alignment

Climate projection information for increases in daily precipitation are not yet available for Ireland. Therefore, to determine the timing of the 20% and 30% increases in extreme precipitation, the TRANSLATE climate projections for changes in winter precipitation have been used as an alternative climate variable (Table A.0.10) to give an indication of the potential future trends in changing

precipitation. The winter season was selected as this shows the largest increases in precipitation, and therefore aligns with the conservative approach of the NCCRA.

Scenario	Time Period	Winter Precipitation Change (%)		
		10th	50th	90th
RCP4.5	2021-2050	-1.14	6.93	16.45
	2041-2070	-1.05	7.70	19.73
	2071-2100	3.80	11.49	19.21
RCP8.5	2021-2050	0.21	7.14	15.71
	2041-2070	3.70	12.46	22.24
	2071-2100	9.96	20.89	32.97

Table A.0.10: TRANSLATE projections for change in Winter Precipitation relative to 1976-2001. The 90th percentile changes are used to align with the OPW Scenarios to align with a conservative approach. Source: O'Brien et al. (2023).

Within an RCP4.5 scenario, there is an increase in winter precipitation of 19.73% (90th percentile), for the period 2041-2070, and a minor decrease for the period 2070-2100 (Table A.0.10). This indicates that the 20% increase in precipitation within the MRFS scenario aligns approximately with 2050, with limited change in precipitation by 2100.

For the RCP8.5 scenario, there is an increase in winter precipitation of 22.24% (90th percentile), within the 2041-2070 time period, and an increase of 32.97% for the 2071-2100 time period (Table A.0.10). This indicates that the 20% increase in precipitation for the MRFS scenario aligns approximately with 2050, with a further increase in precipitation by 2100 aligning with the HEFS scenario.

Table A.0.11 shows the data to be used for assessing fluvial flooding within the NCCRA. For RCP4.5, NIFM and CFRAM MRFS data are employed to assess AEPs 5%, 1%, and 0.1%. For RCP8.5, NIFM and CFRAM HEFS data are used to assess AEPS 1% and 0.1%. For the 5% AEP, NIFM HEFS data is used, however, as CFRAM HEFS data is unavailable, the 1% Present Day AEP has

been employed as following OPW analysis, this AEP/Scenario is the closest uplift in percentage terms to the 5% HEFS relative to 5% Present Day.

The datasets assigned are available within the CFRAM and/or NIFM datasets which, between them, provide national spatial coverage.

Annual Exceedance Probability	Present Day	RCP4.5		RCP8.5	
		2050	2100	2050	2100
50%	-	-	-	-	-
20%	-	-	-	-	-
10%	-	-	-	-	-
5%	5% (Present)[1]	5% (MRFS)[1]	5% (MRFS)[1]	5% (MRFS)[1]	NIFM: 5% (HEFS) CFRAM: 1% (Present)
2%	-	-	-	-	-
1%	1% (Present)[1]	1% (MRFS)[1]	1% (MRFS)[1]	1% (MRFS)[1]	1% (HEFS)[1]
0.5%	-	-	-	-	-
0.1%	0.1% (Present)[1]	0.1% (MRFS)[1]	0.1% (MRFS)[1]	0.1% (MRFS)[1]	0.1% (HEFS)[1]

Table A.0.11: The representative river flood extents that will be used within the NCCRA for each Annual Exceedance Probabilities and future changes in precipitation under RCP4.5 and RCP8.5 scenarios. [1]Both NIFM and CFRAM data are used for the AEP/Scenario.

ISBN: 978-1-80009-205-1