



Donegal County Council

Climate Change Risk Assessment



LACAP
Final Report
26th May 2023



KPMG
Sustainable
Futures



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Executive Summary



Executive Summary

Context and Scope of this Report

Climate change poses a critical challenge for County Donegal. It will result in a wide range of impacts across the county, from damaging infrastructure such as roads and bridges, to biodiversity loss and water supply restrictions. These bring substantial implications for Donegal County Council.

Internationally, national and local governments are increasingly compelled to take ambitious action to increase resilience to climate change within their organisations and their functional areas through adaptation and mitigation measures.

Ireland's Climate Action and Low Carbon Development (Amendment) Act, 2021 highlights the role of the Local Authority in meeting national emission reductions targets and achieving climate resilience. The Act stipulates that local authorities need to prepare a Local Authority Climate Action Plan (LACAP) that will drive local response to the challenges posed by climate change, translating the national climate policy to the local level.

This report provides an assessment of climate change risks and impacts for County Donegal and the implications of these for Donegal County Council. The aim of the report is to provide the evidence base to inform the development of the LACAP for Donegal County Council.

Key Results and Findings

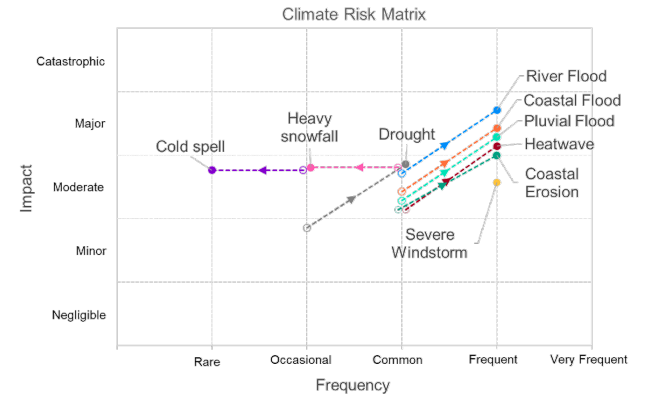
As illustrated in the climate risk matrix on the right, projections indicate that the level of risk posed by some hazards (e.g., coastal erosion, coastal, river and pluvial flooding, heatwaves and drought) will increase while others will remain the same (e.g., severe windstorms).

The level of risk associated with some hazards are expected to decrease, such as cold spells and heavy snowfalls.

- Recent experiences of **river and pluvial flooding** events (e.g., in 2018, 2019 and 2022), resulted in damages to buildings and infrastructure, disruption of transport networks and substantial impacts for business and the local economy. Projected increases in the frequency of extreme precipitation events will result in increased surface water and riverine flood risk for County Donegal.
- Coastal erosion and coastal flooding** already pose a significant risk for County Donegal and have resulted in temporary inundation of buildings, loss of transport infrastructure, and damage to water treatment and wastewater infrastructure. Rising sea levels will increase the rate of coastal erosion and frequency of coastal inundation, resulting in an increased level of risk associated with coastal erosion and flood risk for County Donegal.
- Severe windstorms** are currently experienced on a frequent basis in County Donegal and result in wide-ranging impacts, including disruption to energy supply, communications and transport networks. Projections indicate no significant change to this frequency.
- County Donegal experienced both a **heatwave and drought** in 2018, with heatwaves also recorded in 2021 and 2022. These events resulted in damage to road surfaces (e.g. boiling tar in Killyclug), increased demand placed on water resources and recreational areas, and detrimental impacts on freshwater quality and fish populations. Projected increases in the frequency of heatwaves and drought conditions will mean that events currently experienced on an infrequent basis will become more frequent.

- Recent experiences of **cold spells and heavy snowfall** events in 2018 (e.g. Storm Emma) demonstrated the wide range of impacts for County Donegal. These included, amongst others, disruption to road networks, power outages and impacts on water resources with substantial impacts for business and the local economy. Projected increases in average temperature and decreases in the frequency of cold spells, heavy snowfall, and their associated impacts.

To increase resilience, Donegal County Council will need to proactively plan for and adapt to the **current and future climate change risks** identified through this report.



The risk matrix above shows the current and future level of risk associated with climate hazards for County Donegal. The hollow marker showing the current level of risk and the solid marker the future level of risk. The dotted line shows the change between the current and future risk.



02

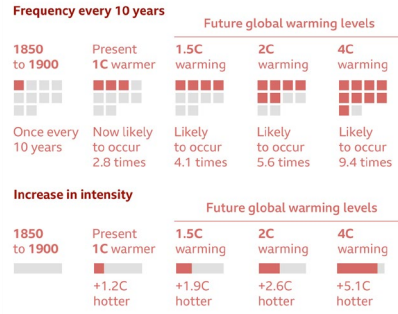
Introduction

Global Response to the Challenge of Climate Change

Global Climate Change Challenge

Extreme heat becomes more frequent

Projected increase in frequency and intensity of high temperatures which only occurred once in every 10 years on average in a climate without human influence



Source: IPCC, 2021: Summary for Policymakers



It is unequivocal that human influence has warmed the atmosphere, land and ocean since pre-industrial times, affecting many weather and climate extremes in every region across the globe. Each of the last four decades has been successively warmer than any decade that preceded it since instrumental records began in 1850.

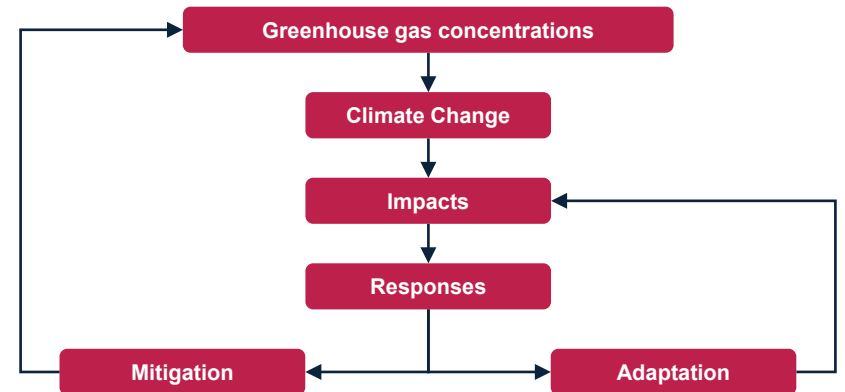
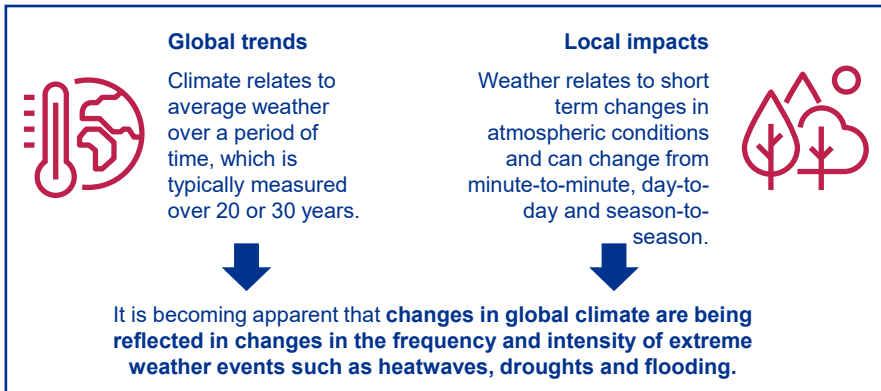
Since 1990, the Intergovernmental Panel on Climate Change (IPCC) have published a series of assessment reports which provide a synthesis of the most up-to-date science and evidence of climate change. The most recent assessment report shows that the global average temperature has increased by 1.1°C when compared with pre-industrial conditions (1850-1900).

Global Climate Change Response Framework

In response to the challenges posed by climate change, two complementary approaches are being adopted.

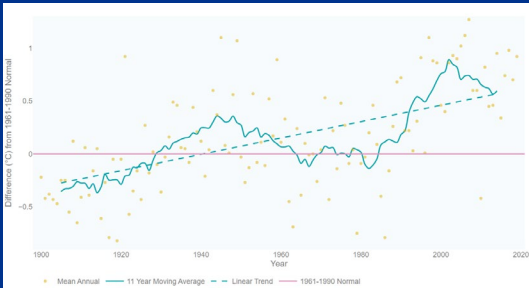
Mitigation: Making the impacts of climate change less severe by preventing or reducing the emission of greenhouse gases (GHGs) into the atmosphere. Mitigation is achieved either by reducing the sources of these gases (e.g. by increasing the share of renewable energies, or establishing a cleaner mobility system) or by enhancing the storage of these gases (e.g. by increasing levels of afforestation). In short, mitigation is a human intervention that reduces the sources of GHG emissions and/or enhances GHG sinks.

Adaptation: Anticipating the adverse impacts of climate change and taking appropriate action to prevent or minimise the damage they can cause, or taking advantage of opportunities that may arise. Examples of adaptation measures include large-scale infrastructure changes, such as building defences to protect against sea-level rise, as well as behavioural shifts, such as individuals reducing their food waste. In essence, adaptation can be understood as the process of adjusting to the current and future effects of climate change.



Ireland's Challenge of Climate Change

Observed Impacts of Climate Change on Ireland



The mean annual observed temperature for Ireland (1900-2019) (Source: Cámaro García and Dwyer, 2021)

According to the Environmental Protection Agency (EPA) Ireland's climate is changing in line with global trends, with an increase in annual average temperature of 0.9 °C between 1900 and 2018. Ireland has seen an increase in annual average rainfall of approx. 6% for the period 1989-2018 when compared to 1961-1990. Global sea level is rising at an increasing rate with the average global rate of sea level rise for the period 2006-2015 being about 2.5 times the rate for the period 1901-1990.



- Surface air temperature has increased, on average, by 0.9 °C during the past 120 years.



- Yearly precipitation was, on average, 6% higher in the 30 years from 1989-2018 as compared to 1961-1990.
- The period 2006 to 2015 was shown to be the wettest in Ireland since records began.



- Due to limited analysis, no long-term change in windiness have been observed.



- For the seas around Ireland, there has been a rise in sea level of approximately 2-3 mm per annum since 1990.
- Sea surface temperature at Malin Head has been, on average, 0.47 °C higher over the period 2009 to 2018 when compared to the average for the period 1981 to 2010.

Projected Impacts of Climate Change on Ireland

Climate projections indicate that observed changes in Ireland's climate will continue and likely intensify into the future. It is expected that Ireland's climate will become warmer and drier, sea levels will continue to increase at a faster rate and that extreme weather events will occur more frequently. Even if mitigation actions are taken over the next 30 years, a level of projected changes are locked in for the foreseeable future as a result of historical GHG emissions. As a result, temperatures will continue to increase globally until at least 2050, even under low emissions scenarios.



- By 2050, average annual temperatures are expected to increase by up to 1.6°C under a high emissions scenario.

- The frequency and intensity of heatwave events are projected to increase.



- By 2050, Levels of summer precipitation are expected to decrease by up to 17% under a high emissions scenario.

- During winter and autumn months, there is expected to be an increase of up to 19% in the occurrence of heavy precipitation events.

- By 2050, Projections indicate a small reduction in overall wind speed (10m) by up to -3.3% under a high emissions scenario.



- Projections of severe windstorms show a high degree of uncertainty with some projections indicating an increase in very severe windstorms. However, more work is required to increase confidence in these projections.

- Global sea level is expected to continue to and by up to 1m by 2100.



- Projections indicate that the Irish Sea could warm by a further 1.9 °C before the end of the 21st Century

Source: Local Authority Climate Action Plan Guidelines, pages 26-29.

National and Local Response

Paris Agreement, 2015

The Paris Agreement, adopted in 2015 provides an internationally accepted and legally binding global framework to address climate change challenges. It has two clearly defined goals aimed at supporting progressive and ambitious climate action to avoid dangerous climate change:

- I. holding global average temperature increase to well below 2°C and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels (i.e., **mitigation**);
- II. increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience (i.e., **adaptation**).

European Climate Law, 2021

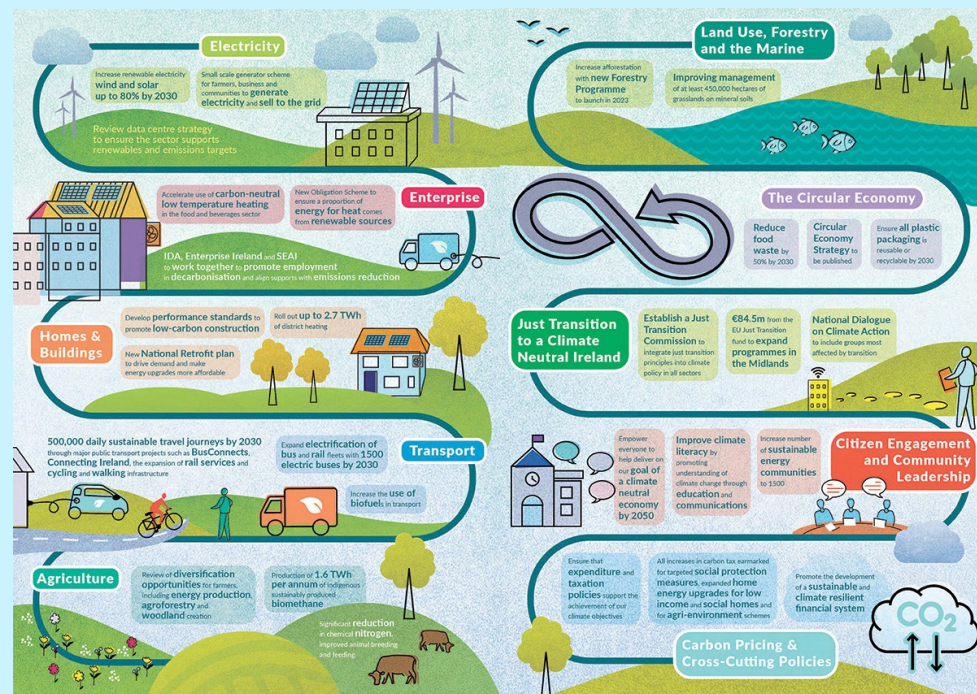
The EU adopted a legislative proposal for the European Climate Law in June 2021 to frame the climate neutrality objective by 2050 across the EU with an intermediate target of **reducing net greenhouse gas emissions by at least 55% by 2030**. The European Commission (EC) is clear in the commitment required by all Member States, and the use of all policy levers and instruments, to fight against the urgent challenge of climate change and to activate leadership efforts to reach climate neutrality by 2050.

Climate Action and Low Carbon Development (Amendment) Act, 2021

Climate policy in Ireland reflects the ambition of the EU and that required to confront the challenges of climate change. The Climate Action and Low Carbon Development (Amendment) Act, 2021 frames Ireland's legally binding climate ambition to delivering a **reduction in greenhouse gas emissions of 51% by 2030**, and to achieve climate neutrality by the end of 2050.

Through progressive economy-wide carbon budgets, sectoral ceilings, a suite of strategies devised to promote a **combination of adaptation and mitigation measures**, and robust oversight and reporting arrangements, climate policy is working to scale up efforts across all of society and deliver a step change on ambitious and transformative climate action to 2030 and beyond to 2050.

Climate Action Plan 2021 - Infographic



Project Overview



Legislative context

Climate Policy in Ireland is aligned with the EU's ambitions to combat Climate Change. The Climate Action and Low Carbon Development (Amendment) Act 2021 enshrines the National Climate Objective to “pursue and achieve, by no later than the end of 2050, the transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy.”

The importance of place-based approaches and the role of the Local Authority is highlighted in the Act, which stipulates that “each local authority shall prepare and make a plan relating to a period of five years (in this section referred to as a 'local authority climate action plan') which shall specify the **mitigation measures** and the **adaptation measures** to be adopted by the local authority.”

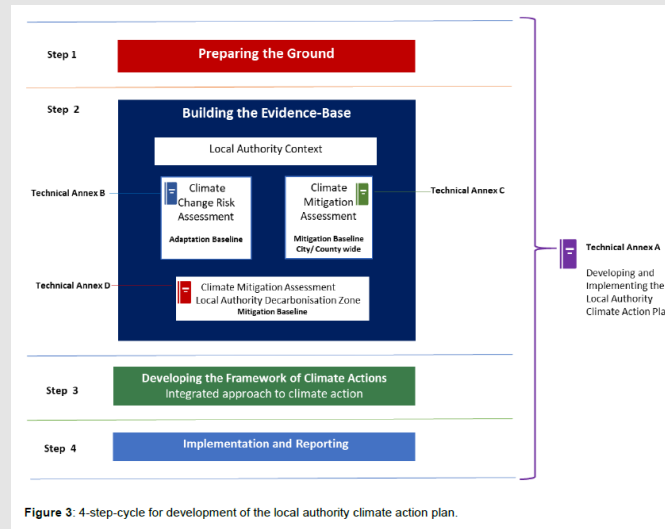
These plans will drive the mitigation and adaptation measures at the local level and see local authorities translate national climate policy to local circumstances and to support the delivery of the National Climate Objective at local and community levels.



Preparing local authorities' climate action plans

To support local authorities in meeting their legislative requirements, the Climate Action Regional Offices (CAROs) developed the draft Local Authority Climate Action Plan (LACAP) Guidelines.

These guidelines structure the development and implementation of LACAP around a 4-step cycle, which is supported by four technical annexes¹:



¹ Source: *Local Authority Climate Action Plan Guidelines*, page 5.



Scope of this report

Per Donegal County Council's request, the KPMG team is supporting the council in Step 2 to build the adaptation baseline and develop a climate change risk assessment (CCRA) following **Technical Annex B of the LACAP Guidelines** in order to understand current and future risks posed by climate change for County Donegal and the implications of these for Donegal County Council.



03

Climate Change Risk Assessment Methodology

3.1 Introduction, Scope and Methodology

Understanding of Climate Change Risk Assessment

Purpose of Climate Change Risk Assessment

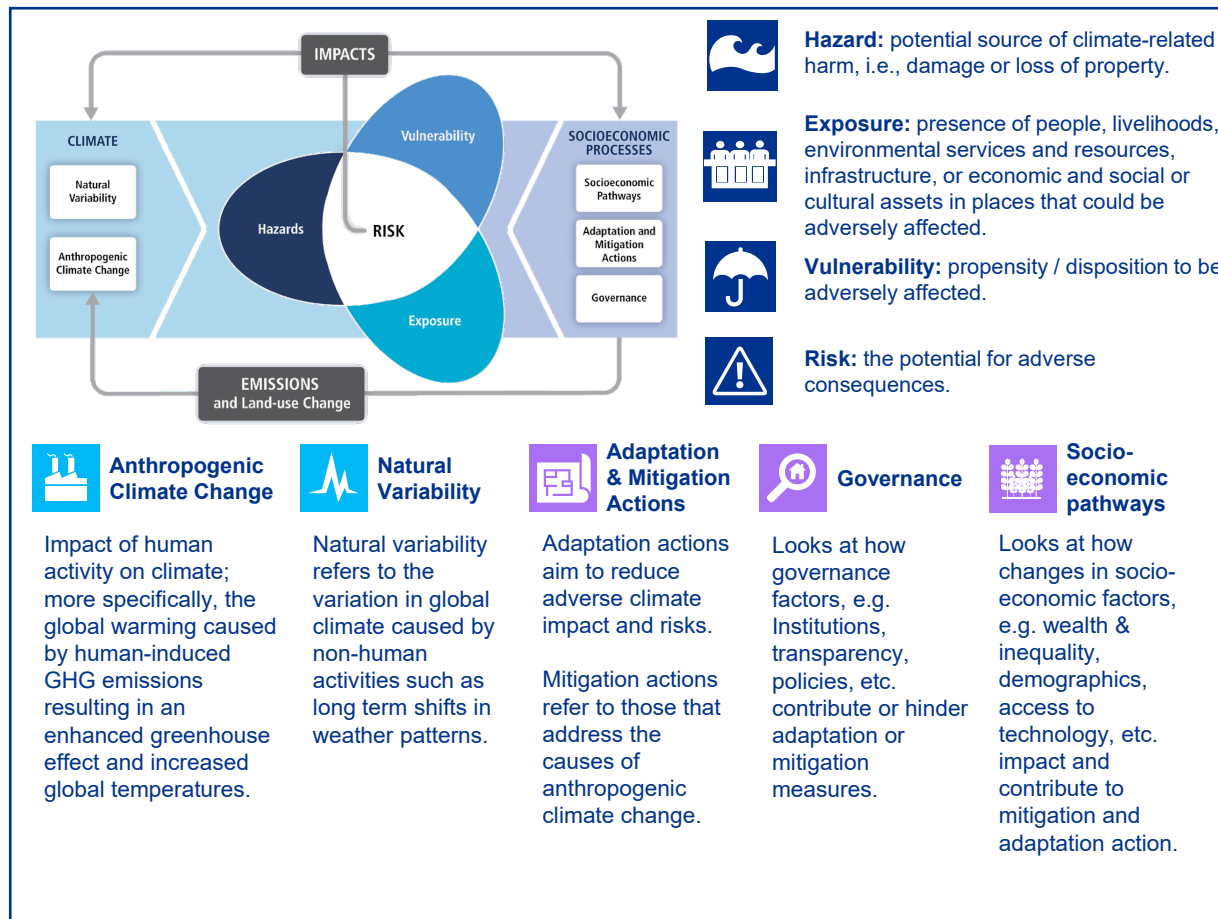
Responding to climate change impacts involves taking adaptation actions to reduce the adverse risks posed by current and projected climate change.

Climate change risk assessments identify the likelihood of future climate hazards and their potential impacts. This is fundamental for informing the prioritisation of climate action and investment in climate action.

Nature of Climate Change Risk Assessment

Conventional 'predict and act' approaches to risk assessment are challenged by the inherent uncertainty associated with climate change, the spatial and temporal dynamics of climate change, the amplification of risk through societal preferences and values and through the interaction of multiple risk factors.

In assessing climate change risk for Donegal County Council, the risk assessment framework of the Intergovernmental Panel on Climate Change (IPCC) has been adopted. This framework identifies three key components of climate risk: hazard, exposure and vulnerability. Details of the framework are provided to the right.



Source: Local Authority Climate Action Plan Guidelines, Technical Annex B, Figure 1. (page 5)

Methodology Climate Change Risk Assessment (CCRA)

Qualitative Assessment

This Climate Change Risk Assessment has been undertaken in accordance with *Technical Annex B Climate Change Risk Assessment* of the Local Authorities Climate Action Plan Guidelines and provides a qualitative assessment of climate risk for County Donegal.

A qualitative risk assessment provides the evidence base to identify potential climate risks for the administrative area of Donegal County Council and for the delivery of services by Donegal County Council.

The Technical Annex B provides a stepped approach to carrying out a climate change risk assessment:

1. Assess the climate impact baseline, identifying, assessing and characterising the climate and weather-related impacts already being experienced by the authority, and
2. Identify and assess potential future climate impacts and risks.

In assessing climate change risk, we employ climate information derived from *Nolan and Flanagan (2020)* and *Climate Ireland* for two climate scenarios, RCP4.5 and RCP 8.5.

- RCP4.5 represents an 'intermediate emissions' scenario with an average global warming of 1.4°C for the 2046-2065 period.
- RCP8.5 represents a 'very high emissions' scenario with an average global warming of 2°C for the 2046-2065 period.

The RCP8.5 scenario was used as it represents a 'worst-case' scenario which allows for a conservative risk assessment approach.

Qualitative

- A qualitative assessment is developed based on readily available information and provides for a screening of climate change related hazards and risks.
- This type of assessment helps to:
 - Identify the full range of climate-related risks;
 - Communicate identified risks to relevant stakeholders;
 - Prioritise risks for further more detailed analysis; and
 - Provide a broad understanding of where adaptation actions could be required.

Semi-quantitative

- A semi-quantitative risk assessment builds upon a qualitative screening assessment and provides a more detailed assessment of climate change risks. Semi-quantitative risk assessments use national and regional information and data along with expert judgement to explore potential risks in further detail.
- This type of assessment helps to:
 - Provide semi-quantitative risk analysis insights;
 - Identify on a spatial basis climate risk hotspots;
 - Identify where adaptation measures may be required.

Quantitative

- A quantitative risk assessment uses site-specific data and expert knowledge to establish a detailed understanding of risks and identify the point in time in the future when the risk will pass the tolerable limit and when implementation of action will be necessary.
- This type of assessment helps to:
 - Detail an estimation of rate of change (when the risk will cross the limit and need action); and
 - Identify the extent of impact (how badly it will affect the system).

Methodology Overview

As detailed below, **Technical Annex B Climate Change Risk Assessment** provides for a proportionate and stepped approach for undertaking a Tier 1 Climate Change Risk Assessment. An assessment of the current climate hazards, exposure, vulnerabilities and impacts leads to the '**Current Climate Risks and Impacts**'. This is followed by an assessment of future climate risks and impacts, resulting in the '**Future Climate Risks and Impacts**'. The detailed steps for both current and future climate risk and impacts are discussed in further pages.

Step 1. Current Climate Risks and Impacts

- Develop Profile of Climate Hazards
- Characterise Climate Hazards Frequency
- Exposure, Vulnerability and Impacts for County Donegal
- Impact Assessment (Service Delivery)
- Current Climate Risk Matrix

Step 2. Future Climate Risks and Impacts

- Assess Future Changes in Climate Hazards Frequency and Intensity
- Assess Future Change in Exposure and Vulnerability
- Assess Emerging Hazards and Potential Future Climate Risks
- Future Climate Risk Matrix
- Uncertainty Assessment

Step 1: Assess Current Climate Risks and Impacts

In assessing current climate risks and impacts, developing an understanding of the range of climate and weather related events currently impacting County Donegal and the consequence of these for Donegal County Council is essential. To achieve this, a number of steps have been undertaken as detailed below:

1.1

Develop Profile of Climate Hazards

The climate hazard profile provides an overview of climate and weather-related hazards to have impacted the County Donegal.

We have updated the climate hazard profile developed through the existing Donegal County Council Climate Adaptation Strategy (2019) in accordance with recent experiences of extreme weather and climate variability.

Section 3.2.1

1.2

Characterise Climate Hazards-Frequency

On the basis of the most up-to-date information on extreme weather events and observed climate changes for Ireland, the frequency of occurrence of the climate hazards identified through the climate hazard profile has been assessed according to the criteria provided through **Technical Annex B: Climate Change Risk Assessment**.

Section 3.2.1

1.3

Exposure, Vulnerability and Impacts for County Donegal

For each of the climate hazards identified through the climate hazard profile, an assessment of the local-scale impacts, exposure, and vulnerability has been performed based on reported impacts and in discussion with the local authority.

Section 3.2.2

1.4

Impact Assessment (Service Delivery)

The level of disruption to the delivery of services by the council has been assessed for each of the identified climate hazards following the criteria provided through **Technical Annex B: Climate Change Risk Assessment**.

Section 3.2.3

1.5

Current Climate Risk Matrix

The overall impact of the identified climate hazards has been assessed according to the following categories of exposure: Asset Damage, Health and Wellbeing, Environment, Social, Financial, Reputation and Cultural Heritage. A summary of current climate impacts has been provided through a current climate risk matrix.

Section 3.2.4

Step 2: Assess Future Climate Risks and Impacts

Building on the assessment of current climate impacts, assessing future climate risks and impacts is concerned with understanding and characterising how projected changes in the frequency and intensity of climate hazards may exacerbate existing climate impacts and risks for County Donegal. To achieve this, a number of steps have been undertaken and as detailed below:

2.1

Assess Future Changes in Climate Hazards-Frequency and Intensity

The most up-to-date climate change projections have been employed to assess the changes in frequency and intensity of climate hazards identified through our assessment of current climate impacts.

Section 3.3.1

2.2

Assess Future Change in Exposure and Vulnerability

To identify and assess the potential future changes in exposure and vulnerability, projections of potential changes in non-climatic factors (e.g. *County Development Plans, Regional Social and Economic Strategies*) have been examined. The assessment of the projected future impacts have been provided.

Section 3.3.2

2.3

Assess Emerging Hazards and potential Future Climate Risks

In addition to those hazards and impacts identified through the current climate impact and risk assessment, projected climate change may result in new or emerging risks. Emerging risks for County Donegal have been identified and considered as part of the CCRA.

Section 3.3.2

2.4

Future Climate Risk Matrix

Accounting for projected changes in hazard, exposure and vulnerability, future climate risk has been assessed according to the following categories of exposure: Asset Damage, Health and Wellbeing, Environment, Social, Financial, Reputation and Cultural Heritage. A summary of potential future climate impacts is provided through a future climate risk matrix.

Section 3.3.3

2.5

Uncertainty Assessment

In assessing future climate risks, there will be uncertainty in how hazards, exposure, and vulnerability will change. The level of uncertainty in projected changes in climate hazards, exposure, and vulnerability is assessed.

Section 3.3.4

Data and Information Sources

As detailed below, a wide range of qualitative and quantitative and information was employed to inform the development of the CCRA for Donegal County Council. The Donegal Council Adaptation Strategy 2019-2024 was reviewed and updated using a range of national and local data sources. Climate Ireland was employed to access data and information on projected changes in the frequency and intensity of climate hazards while the National Planning Framework, Donegal County Council Development Plan 2018-2024 and the Regional Spatial and Economic Strategy for the Northern and Western Region were employed to assess future development patterns. In addition, two stakeholder workshops were held to garner further insights from Donegal County Council.

Report Section	Sources
Introduction and scope	<ul style="list-style-type: none"> Local Authority Climate Action Plan Guidelines, Technical Annex
Step 1: Current Climate Risks and Impacts	<ul style="list-style-type: none"> Environmental Protection Agency (EPA) Catchments.ie (EPA) Climate Status Report 2020 (Cámaro García and Dwyer, 2021) Floodinfo.ie (Office of Public Works) Data.gov.ie Department of Transport Department of Housing, Local Government and Heritage Department of Transport, Sport and Tourism Teagasc Met Éireann Inland Fisheries Ireland Donegal County Council Website Donegal County Council Adaptation Strategy 2019-2024 Sectoral Climate Change Adaptation Strategies (2018) Stakeholder Workshop RTE News Irish Independent Irish Examiner The Irish Times The Irish Mirror The Journal The Farmers Journal Agriland Donegal Daily Donegal Live Donegal News Donegal Weather Channel Highland Radio
Step 2: Future Climate Risks and Impacts	<ul style="list-style-type: none"> High-resolution Climate Projections for Ireland – A Multi-model Ensemble Approach (Nolan and Flanagan, 2020) accessed via Climate Ireland Regional Spatial & Economic Strategy for the Northern and Western Region Assembly Transport Infrastructure Ireland County Donegal Development Plan 2018-2024

3.2 Current Climate Risks and Impacts

3.2.1 Profile of Climate Hazards (incl. Frequency)

Characteristics of County Donegal

Donegal County Council is a member of the Atlantic Seaboard North Climate Action Regional Office (CARO) which coordinates climate action undertaken by the five Local Authorities of Donegal, Sligo, Mayo, Galway County and Galway City. According to the Census 2022, Donegal County Council serves 166,321 people. The border county is known as one of the most scenic parts of Ireland, famous for its high-quality landscape, outdoor activities and diverse local economy.

Physical & Environmental Characteristics

County Donegal is approximately 4,861 km² making it the 4th largest county in Ireland. The county is bounded by a 1,132 km Atlantic Ocean coastline (or 20% of the country's total coastline) as well as by counties Tyrone, Derry, Fermanagh and Leitrim.

The county is home to the most northerly point in Ireland, Malin Head, which is located on the Inishowen Peninsula. As part of the Wild Atlantic Way tourist route, Donegal has 39 coastal Discovery Points and 3 Signature points, including Sliabh Liag, Fanad Head and Malin Head. The county has 12 Blue Flag Beaches, 2 Blue Flag Marinas and 4 beaches achieving Green Coast Awards, as well as being home to Bundoran, a world-famous surf break destination located in the south of the county.

Some 26% of the county's landmass is designated for the protection of its rich flora and fauna species. This includes Glenveagh National Park, Derryveagh Mountains, Ards Forest as well as nature reserves at Lough Barra Bog, Meenachullion, Pettigo Plateau and Ardnamona. The county is also home of the Slieve League cliffs which are amongst Europe's highest.

Socioeconomic Characteristics

According to the 2022 Census, Donegal has a population of 166,321 people, which represents a 7,129 increase since the 2016 Census. The county has experienced relatively steady population growth over recent years and has an almost exactly equal gender breakdown. 91% of the county's population is Irish by nationality and almost 40% of the population speaks Irish.

Donegal is linked to Dublin via the N3, Belfast via the M1, Sligo via the N15 and Galway via the N15 and the N17. The county has its own airport at Carrickfinn and the City of Derry Airport is also located in close proximity to the county. The nearest international airport to Donegal town, meanwhile, is in Belfast (approx. 175 km distant).

The county comprises of 5 municipal districts, Donegal, Glenties, Letterkenny-Milford, Inishowen, and Lifford-Stranorlar. The largest towns in the county are Letterkenny, Buncrana and Ballybofey-Stranorlar which have a population of 19,274 and 6,785, and 4,852 people respectively (2016 Census).

Donegal is a largely rural county, with over 70% of the population living in towns, villages and rural areas. According to the CSO, in 2010 there were 9,240 farms in Donegal, with an average farm size of 28 ha.

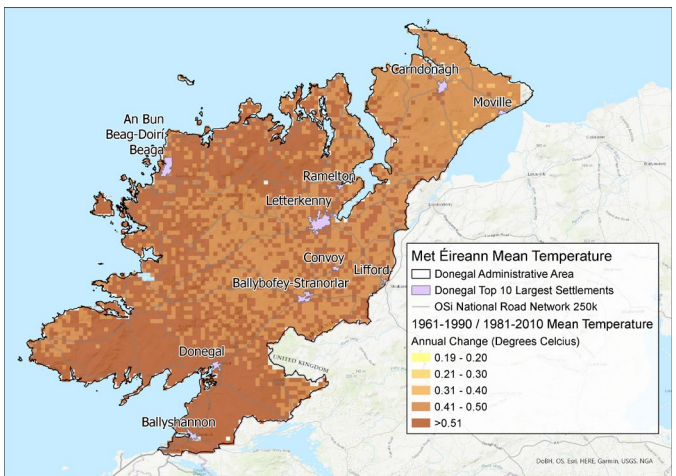
Approximately 39% of the county's area is in agricultural use, with almost half of this figure specialising in beef production. Donegal is also home to 20% of Ireland's sheep farming enterprises.

Tourism is a major driver of Donegal's economy, and the county offers a range of experiences such as horse riding, angling, sailing, surfing, walking, cycling and eco-tourism. In 2016, Failte Ireland reported that tourism attracted over 650,000 visitors to the county and generated over €285 million for the local economy.

According to the 2016 Census, Donegal's largest employment sectors are Professional Services (26%) and Commerce and Trade (20%) and Manufacturing (9%). Other industries such as Agriculture, Constructions, Public Administration, Transport and Communications also play a significant role in the local economy.

According to the 2016 Census, the county's Household Median Gross Income was €32,259, and in 2021 the council provided a total of 1,763 Housing Assistance Payments.

Observed Changes in Donegal's Climate



To assess changes in climatic conditions for County Donegal, we have employed data from Met Éireann's long term weather station at 'Malin Head'.

In line with global trends, the climate of Ireland and Donegal is changing, temperatures are increasing and patterns of precipitation are changing. A summary of key climate and weather-related changes already observed for County Donegal are detailed below.

Highlights of Observed Climate Change for Ireland and Donegal

Sea Level Rise



Sea levels in Ireland have risen by approximately 2-3mm per year since the early 1990s according to satellite measurements**

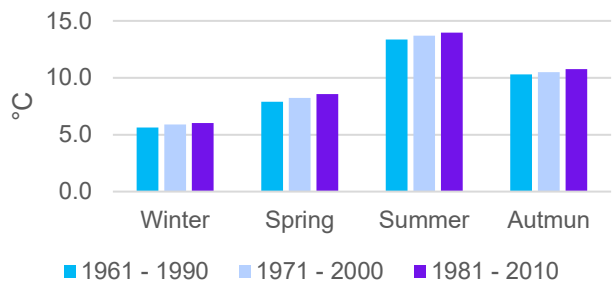
Rainfall

Average annual rainfall at Malin Head has increased by 1.5% for the most recent period (1981-2010) compared to the 1961-1990 baseline.*

0.5°C

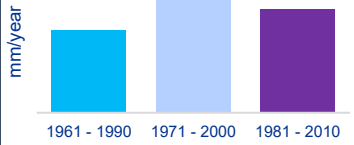
Average temperature increase for the period 1981-2010 when compared to the 1961-1990 baseline.*

Mean Seasonal Temperatures



31°C

Highest temperature on record for County Donegal, recorded on July 28th 2018 at Glenties Hatchery



4 of the wettest years recorded were in the last 10 years based on records extending back to 1955*

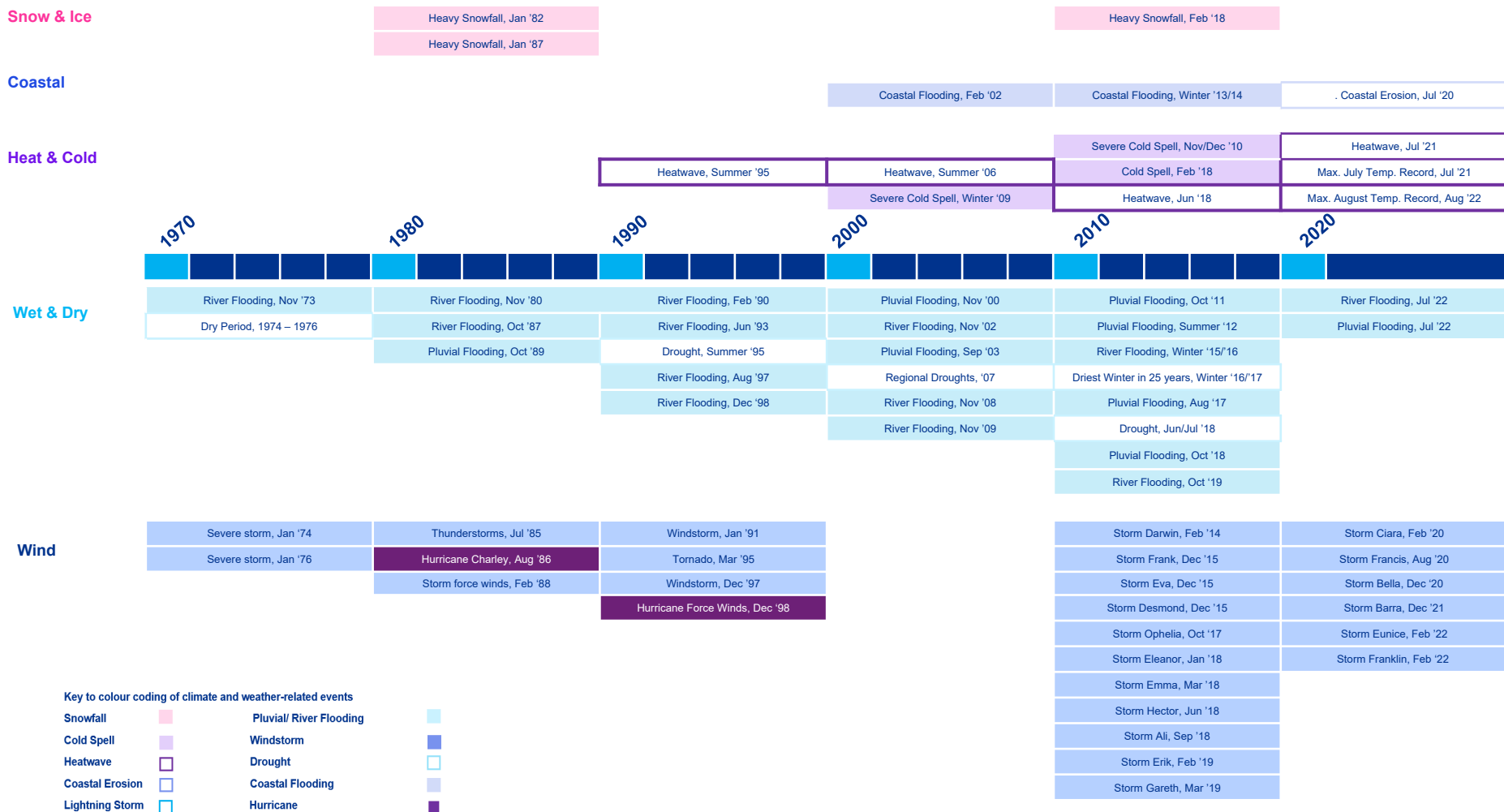
*Source: Met Éireann Long term weather station : Malin Head
 **Source: EPA: Climate Status Report for Ireland, 2020
 ***Source: Donegalnews, 2022



In 2017, 63 mm of rainfall fell over a 6 hour period resulting in damages to roads and bridges in Donegal and the Inishowen peninsula in particular.

Climate Hazard Profile

In addition to observed changes in Donegal's climate, we have identified significant climate and weather-related events to have impacted on the CARO ASBN region and County Donegal over the period 1973-2022. To do this, we have further developed the existing climate hazard profile developed for the CARO ASBN region and County Donegal through the Donegal County Council Adaptation Strategy (2019) and expanded the analysis to cover the period 2018-2022.



Frequency of Climate Hazards

For each of the climate hazards that have been identified through the climate hazard profile, an assessment of their frequency of occurrence has been conducted. Each hazard was assigned a frequency category according to Table 2 of the **Technical Annex B Climate Change Risk Assessment Guidelines** (top right).

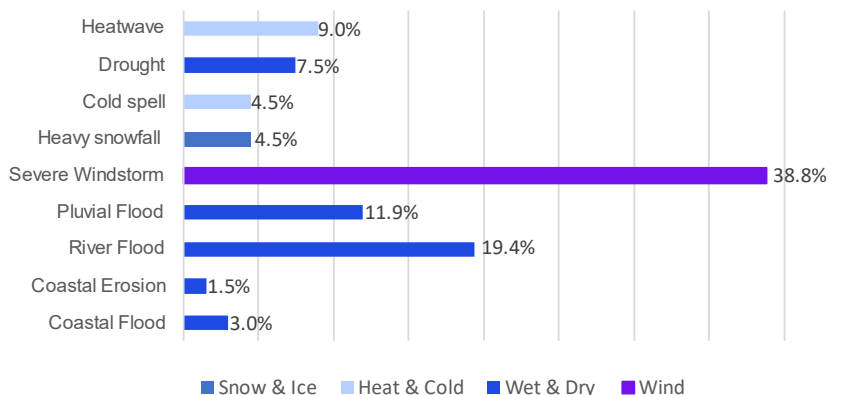
Based on the climate hazard baseline, severe windstorm events have impacted upon County Donegal most frequently over the period 1973-2022, with river and pluvial flooding also affecting the County on a number of occasions. Coastal flooding, coastal erosion, cold spells, heavy snowfall events, heatwaves and droughts have also impacted County Donegal, but less frequently.

The hazard frequency for each hazard is shown in the bottom right table, informed by past event occurrence and information received from Donegal County Council.

Frequency classification from Technical Annex B Climate Change Risk Assessment Guidelines

Frequency	Frequency Occurrence in a Year	Description
Very Frequent	> 100%	Occurs several times in a single year
Frequent	50 to 100%	Occurs once in a 1-to-2-year period
Common	10 to 50%	Occurs once in a 2-to-10 years period
Occasional	1 to 10%	Occurs once in a 10-to-100-year period
Rare	< 1%	Occurs once in over 100 years

Frequency of identified hazard events for the ASBN region and County Donegal (1973 -2022)



Current hazard frequency for Donegal County, based upon analysis of past events and workshop feedback

Hazard Type	Current Frequency
Heatwave	Common
Drought	Occasional
Cold Spell	Occasional
Heavy Snowfall	Common
Severe Windstorm	Frequent
Coastal Flood	Common
Coastal Erosion	Common
Pluvial Flood	Common
River Flood	Common

3.2.2 Exposure, Vulnerability and Impacts for County Donegal

Key to colour coding of impact ratings

- Catastrophic
- Major
- Moderate
- Minor
- Negligible

Exposure, Vulnerability and Impacts for County Donegal

On the basis of identified exposures, vulnerabilities and impacts for County Donegal, the impact of climate and weather-related hazards on key categories of exposure for County Donegal was assessed according to the criteria provided through Technical Annex B: Climate Change Risk Assessment (catastrophic, major, moderate, minor and negligible) (Appendix 2). This assessment was undertaken on the basis of existing information on impacts and in consultation with Donegal County Council.



Below we provide a summary of impacts across the key categories of exposure for the seven climate hazards identified. The following pages provides the information that informed this assessment with additional information provided in Appendix 3.

Hazard	Current Frequency	Assets	Health and Wellbeing	Environment	Social	Cultural Heritage	Financial	Reputational	Overall Impact Score
Heatwave	Common	Moderate	Negligible	Moderate	Minor	Minor	Minor	Minor	2.1
Drought	Occasional	Minor	Negligible	Moderate	Minor	Minor	Minor	Negligible	1.9
Cold Spell	Occasional	Moderate	Moderate	Moderate	Moderate	Minor	Moderate	Minor	2.7
Heavy Snowfall	Common	Major	Moderate	Moderate	Moderate	Minor	Moderate	Minor	2.9
Severe Windstorm	Frequent	Major	Moderate	Minor	Minor	Minor	Moderate	Minor	2.6
Coastal Flood	Common	Moderate	Minor	Moderate	Minor	Minor	Moderate	Minor	2.4
Coastal Erosion	Common	Minor	Negligible	Moderate	Minor	Moderate	Minor	Minor	2.1
Pluvial Flood	Common	Moderate	Minor	Minor	Minor	Minor	Moderate	Minor	2.3
River Flood	Common	Major	Moderate	Moderate	Moderate	Minor	Minor	Minor	2.7

Impacts of Current Climate Risks– Heatwaves & Drought

Key to colour coding of impact ratings
Catastrophic
Major
Moderate
Minor
Negligible

County Donegal has been exposed to heatwave events (defined as 5 consecutive days with temperatures >25°C) over the period 1973-2022 with a wide range of impacts across the county. The most notable and costly impact relates to repair and maintenance of road surfaces and responding to uncontrolled fires. In addition, County Donegal has experienced drought conditions over the period as exemplified by the drought events in 2007 and July 2018.

Hazard & Frequency	Exposure	Impact Description	Rating
 <p>Heatwave Common</p>	Assets	<ul style="list-style-type: none"> High temperatures have resulted in county wide damage to road surfaces (tar and chip) across the county. The 2018 heatwave led to reports of boiling tar across the county, notably on the Donegal road in Killyclug. 	Moderate
	Health and Well being	<ul style="list-style-type: none"> High indoor temperatures have resulted in uncomfortable working conditions for staff and public with the potential for impacts on heat sensitive equipment. This has resulted in the increased requirement for active/mechanical cooling. 	Negligible
	Environment	<ul style="list-style-type: none"> Heat waves have provided suitable conditions for the ignition of uncontrolled fires, with high temperatures in 2021 potentially contributing to 86 wildfires reported across the county. High water temperatures associated with heatwave events have also had significant impacts on freshwater and marine environments. In August 2022, high water temperatures led to a fish kill event involving over 2,250 juvenile brown trout and Atlantic salmon in the Glengannon river at Inishowen due to thermal stress. 	Moderate
	Social	<ul style="list-style-type: none"> Increased sea surface temperatures can result in higher frequencies of jellyfish on coasts. In June and July 2022 a number of sightings of the potentially harmful Portuguese Man o'War jellyfish washed up on beaches in Derrybeg and Narin. 	Minor
	Cultural Heritage	<ul style="list-style-type: none"> Heatwaves have resulted in congestion at key recreational areas with facilities (e.g., litter collection and parking) overwhelmed. In July 2022, gardai issued a warning to motorists travelling to beaches not to block access to emergency vehicles when parking, particularly at Downings and Marble Hall. 	Minor
	Financial	<ul style="list-style-type: none"> The financial implications of heatwaves are primarily associated with road maintenance and repair. 	Minor
	Reputational	<ul style="list-style-type: none"> Reputational impacts of heatwaves are limited and associated with short term media reporting on council preparedness and response. 	Minor
 <p>Drought Occasional</p>	Assets	<ul style="list-style-type: none"> Drought conditions resulted in the imposition of restrictions on water supply on a national and county basis with potential implications for building operation. In August 2022, Irish Water experienced water shortages in Lettermacaward WTP, Loughmourne WTP (Meencrumlin), and Carrigart WTP, leading to night-time restrictions on water usage for customers in the Lough Mourne Water scheme. In July 2021, water restrictions were placed on Lifford, Convoy, Raphoe, Castlefinn, Ballybofey, Stanorlar and Glenfin. 	Minor
	Health and Well being	<ul style="list-style-type: none"> Water restrictions, particularly in combination with extreme heat, have the potential to result in dehydration, this is particularly the case for vulnerable populations and outdoor workers. 	Negligible
	Environment	<ul style="list-style-type: none"> High temperatures and dry conditions, often compounded by high levels of ignition activity, have resulted in uncontrolled fires. In 2021 this led to 86 wild fires throughout the county. In 2019, dry conditions led to a series of large gorse fires threatening the villages of Annagry, Loughanure, Belcruit and Dungloe. 	Moderate
	Social	<ul style="list-style-type: none"> Water restrictions can lead to inconvenience for local businesses and resident. In June '18, Malin Head recorded 21 consecutive days of zero rainfall, leading to night time water restrictions on the water supplies of Pettigo and Lough Mourne, with a hosepipe ban in place across the entire county. 	Minor
	Cultural Heritage	<ul style="list-style-type: none"> Drought conditions results in damage to cultural heritage sites due to drying out of substrate. 	Minor
	Financial	<ul style="list-style-type: none"> The financial implications of drought are limited and restricted to responding to wildfire and supporting the provision of water (e.g., tankering). 	Minor
	Reputational	<ul style="list-style-type: none"> Droughts, associated impacts and response have the potential for a localised and temporary impact on public opinion. 	Negligible

Impacts of Current Climate Risks – Cold Spells & Heavy Snowfall

Key to colour coding of impact ratings

Catastrophic

Major

Moderate

Minor

Negligible


County Donegal experience cold spells events on an occasional basis and heavy snowfall events on common basis with significant county wide events reported in 2009, 2010 and 2018. These events have wide ranging impacts across the county including disruption of transport routes, damage to buildings, and significant repair and maintenance costs.

Hazard & Frequency	Exposure	Impact Description	Rating
 Cold spell Occasional	Assets	<ul style="list-style-type: none"> Cold spells have resulted in road closure, transport disruption and increased maintenance and repair costs across the county. Storm Emma in 2018 required over 500 tonnes of salt and grit to be spread on roads across the county in 24 hours. Freeze thaw action has resulted in damage to critical infrastructure (e.g., water infrastructure) and building stock. Water restriction were placed on homes in the Lough Mourne Water scheme in December 2022 due to difficulties replenishing reservoirs. Extreme cold conditions in combination with snowfall have resulted in the widespread closure of business (incl. LA business services). 	Moderate
	Health and Well being	<ul style="list-style-type: none"> Extreme cold has resulted in treacherous conditions and increased incidence of slips and falls. Exposure to extreme cold has had detrimental impacts for outdoor workers and vulnerable populations. 	Moderate
	Environment	<ul style="list-style-type: none"> Cold spells have led to decreased water availability and have detrimental impacts for biodiversity and habitats, resulting in a decrease of ecosystem health. 	Moderate
	Social	<ul style="list-style-type: none"> Road closures have resulted in social isolation for remote communities. Elderly and vulnerable populations are required to stay in place resulting in isolation. 	Moderate
	Cultural Heritage	<ul style="list-style-type: none"> Freeze thaw has been identified as having detrimental impact on the structural integrity of cultural heritage sites. 	Minor
	Financial	<ul style="list-style-type: none"> The financial implications of cold spells are primarily associated with maintenance and repair costs for local and regional roads, buildings and assets, and can be significant. 	Moderate
	Reputational	<ul style="list-style-type: none"> Isolation of communities and council response (e.g., gritting) across the county receives media attention but with limited impact on public opinion. 	Minor
 Heavy snowfall Common	Assets	<ul style="list-style-type: none"> Heavy snowfall has resulted in road closures and transport disruption as evidenced with the closure of roads across the county as a result of Storm Emma (2018), which led to snow drifts of up to 30cm in locations such as Creeslough, Dunfanaghy, Falcarragh and Bunrana. Accumulations of snowfall on roofs results in damage to buildings. Flooding post-heavy snowfall events results in the flooding of assets (e.g., roads and infrastructure). 	Major
	Health and Well being	<ul style="list-style-type: none"> Extreme cold events have resulted in treacherous conditions and increased incidence of slips and falls amongst public and staff. 	Moderate
	Environment	<ul style="list-style-type: none"> Flooding post-heavy snowfall event results in overland flow of pollutants to habitats and ecosystems with detrimental effects. 	Moderate
	Social	<ul style="list-style-type: none"> Road closures can result in significant social isolation for remote communities. 	Moderate
	Cultural Heritage	<ul style="list-style-type: none"> Accumulations of heavy snowfall can result in damage to cultural heritage sites. 	Minor
	Financial	<ul style="list-style-type: none"> The financial implications of cold spells are primarily associated with maintenance and repair costs for local and regional roads, buildings and assets. 	Moderate
	Reputational	<ul style="list-style-type: none"> Isolation of communities and council response (e.g., gritting) across the county receives media attention but with limited impact on public opinion. 	Minor

Impacts of Current Climate Risks - Windstorms

County Donegal has been frequently exposed to wind storms over the period 1973-2022, notable examples being Storms Ali, Barra, Desmond and Eunice. Impacts have been experienced across the county and primarily relate to disruption of transport, electricity and communication networks. Severe windstorms also result in health and safety risks, e.g. associated with treefall.

Key to colour coding of impact ratings
Catastrophic
Major
Moderate
Minor
Negligible

Hazard & Frequency	Exposure	Impact Description	Rating
 Severe windstorm Frequent	Assets	<ul style="list-style-type: none"> Windstorms have caused direct damage to building stock and other assets. Notably Storm Barra in 2021 placed significant pressure on Donegal home owners affected by mica. Windstorms have disrupted building operations. Storm Barra in 2021 led to the closure of all schools and colleges in Donegal, as did Storm Eunice in February 2022. Windstorm damage to power and communication transmission infrastructure (e.g., tree fall on overhead lines) has resulted in disruption of communications and energy supply. Windstorms have caused disruption of transport routes as a result of treefall. Storm Barra in 2021 led to the closure of 4 local roads and a regional road. Fallen trees during Storm Hector in 2019 led to the closure of the N14 as well as 3 local roads around Letterkenny. Storm Ali in 2018 forces the closure of the N3, N14 and N15, as well as 4 regional roads. In addition, Storm Gareth in 2019 led to the cancellation of all flights from Donegal airport. Windstorms can impede the function of wind turbines. This can occur through high winds or other associated weather events, as was observed when lightning struck a 116m turbine in Inishowen, leaving dent and scorch marks. 	Major
	Health and Well being	<ul style="list-style-type: none"> Windstorms posed a health and safety risk with potential for injury. During Storm Desmond in Dec '15 with gusts of up to 81 mph, Emergency Services across the county faced increased pressure during the storm and responded to call outs in Bundoran, Ballyshannon, Donegal Town, Ballybofey/Stranorlar, Glenties, Fahan, Creeslough, Kilmacrenan, Bunbeg and Lifford areas. 	Moderate
	Environment	<ul style="list-style-type: none"> Windstorms have resulted in loss of trees and this is particularly the case for vulnerable tree species. 	Minor
	Social	<ul style="list-style-type: none"> Severe windstorms and disruption of transport and communication networks has resulted in isolation of communities. As a result of Storm Eleanor in 2018, Eir saw 50 sites affected nationally. Three and Vodafone had 71 and 30 affected sites respectively. Windstorms can lead to isolation of island communities. Storm Gareth in 2019 led to the cancellation of ferry services to Toraigh and delays to the ferry service to Árainn Mhór. High winds in January 2022 led to the cancellation of ferry services to Árainn Mhór. 	Minor
	Cultural Heritage	<ul style="list-style-type: none"> Severe wind storms can cause structural damage to cultural heritage sites. 	Minor
	Financial	<ul style="list-style-type: none"> The financial impacts of severe wind storm are associated with response, clean-up and repair cost. 	Moderate
	Reputational	<ul style="list-style-type: none"> Reputational damage as a result of wind storms is limited and associated with short term media reporting on council preparedness and response. 	Minor

Impacts of Current Climate Risks - Coastal Flooding and Erosion

Key to colour coding of impact ratings
Catastrophic
Major
Moderate
Minor
Negligible

County Donegal is exposed to coastal storms resulting in inundation of coastal communities. A number of areas are subject to frequent and recurring flooding. County Donegal has 1,235km of coastline (1,031km mainland, 204km islands). 240km of this extent is soft coastline, of which 130km are deemed to be at risk(Collins, 1996).

Hazard & Frequency	Exposure	Impact Description	Rating
 <p>Coastal flood Common</p>	Assets	<ul style="list-style-type: none"> Coastal flooding can result in direct damage to building stock and other assets. For example, In June 2018, Storm Hector led to the Harbour car park in Donegal town to be flooded. Coastal flooding results in transport disruption and road closures. 	Moderate
	Health and Well being	<ul style="list-style-type: none"> Coastal flooding poses risks to health and well being of the public and staff working in exposed areas. 	Minor
	Environment	<ul style="list-style-type: none"> Coastal flooding has detrimental impacts on coastal ecosystems, causing an overall reduction in ecosystem health. Coastal flooding can lead to issues with sewage systems and agricultural runoff. 	Moderate
	Social	<ul style="list-style-type: none"> Closure of transport routes due to coastal flooding results in significant social isolation for isolated communities. Coastal flooding results in damage to amenities located in coastal habitats. The fairways at Portsalon golf club were flooded during Storm Franklin in February 2022. 	Minor
	Cultural Heritage	<ul style="list-style-type: none"> Coastal flooding can cause structural damage to cultural heritage sites not designed to withstand frequent inundation or exposure to corrosive salt water. 	Minor
	Financial	<ul style="list-style-type: none"> Financial implications associated with coastal flooding relate to increased costs associated with emergency response (e.g. pumping), clean-up and repair. Damage and flooding along the Donegal coastline caused by strong winds, tidal surges, very high tides, and high rainfall of the '13/'14 Winter Storms, resulted in €2.2m worth of repairs for Donegal County Council. 	Moderate
	Reputational	<ul style="list-style-type: none"> For those areas subject to frequent inundations, there is potential for reputational damage to the Council on a localised and medium term basis . 	Minor
 <p>Coastal erosion Common</p>	Assets	<ul style="list-style-type: none"> Coastal erosion can damage assets, including transport infrastructure. The Five Fingers area near Malin lost a section of an access road as well as a carpark in 2020. 	Minor
	Health and Well being	<ul style="list-style-type: none"> Coastal erosion results in the loss of land, impacting the health and wellbeing of the community affected. Damage to recreational amenities poses a health and safety risk to the members of the public. 	Negligible
	Environment	<ul style="list-style-type: none"> Coastal erosion results in damage to coastal habitats. The Five Fingers area near Malin lost 100m of sand dunes in 2020. 	Moderate
	Social	<ul style="list-style-type: none"> Road closures as a result of coastal erosion has the potential to result in significant social isolation for communities. 	Minor
	Cultural Heritage	<ul style="list-style-type: none"> Erosion of sand dune systems can take place in protected areas, such as Special Areas of Conservation. Dunes at Culdaff beach are diminishing due to coastal erosion. 	Moderate
	Financial	<ul style="list-style-type: none"> The financial implications of coastal erosion are primarily related to the development and maintenance of coastal defence works. 	Minor
Reputational	<ul style="list-style-type: none"> Coastal erosion issues are localised but can result in short-term impact on public opinion. 	Minor	

Impacts of Current Climate Risks - Pluvial and Fluvial Flooding

For County Donegal in the period 1973-2022, pluvial and fluvial flooding have occurred on a common basis. County Donegal was impacted multiple times by fluvial flooding over the last two decades (e.g. 2002, 2008, 2009, 2015-16, 2019 and 2022) These events have wide impacts across the county including disruption of transport routes, damage to buildings, and environmental impacts. The most notable impacts of pluvial flooding are direct damages to buildings and infrastructures and mobilisation of pollutants.

Key to colour coding of impact ratings	
Catastrophic	Red
Major	Pink
Moderate	Orange
Minor	Yellow
Negligible	Green

Hazard & Frequency	Exposure	Impact Description	Rating
 <p>Pluvial flood Common</p>	Assets	<ul style="list-style-type: none"> Pluvial flooding has resulted in the temporary inundation of assets. Pluvial flooding associated with ex-hurricane Gert in August 2017 inundated vehicles in Carndonagh and Inishowen, causing damage. Flooding caused by Storm Gert in October 2019 damaged several businesses on New Row in Donegal town. Pluvial flooding results in damage to road surfaces and disruption of traffic. Pluvial flooding associated with ex-hurricane Gert in August 2017 caused damage to the R238. 	Moderate
	Health and Wellbeing	<ul style="list-style-type: none"> Heavy precipitation and floodwater leads to dangerous driving conditions for both council staff and public. Pluvial flooding caused by heavy rainfall in July '22 led to a sewerage backup, with raw sewage reported to flow in the Pairc ui Nullian area of Inishowen. Raw sewage poses a significant health risk to populations exposed. 	Minor
	Environment	<ul style="list-style-type: none"> Pluvial flooding has resulted in the overland flow of pollutants (nutrients, sediment and pesticides) with impacts on terrestrial and freshwater ecosystems. A 2020 study noted that 11% of EPA chemical monitoring surveys in Donegal noted higher than the maximum allowable concentration of cypermethrin, a chemical found in agricultural runoff which can have a detrimental effect on aquatic ecosystems. Pluvial flooding can cause landslides and damage to local habitats. 	Minor
	Social	<ul style="list-style-type: none"> Road closures can result in significant social isolation for communities. The R250 in Glenswilly flooded several times in September and October 2022, blocking access to residents' homes. 	Minor
	Cultural Heritage	<ul style="list-style-type: none"> Pluvial flooding puts built heritage with stone cavities at risk of soakage and leakage. 	Minor
	Financial	<ul style="list-style-type: none"> The financial implications of emergency response (e.g. pumping and emergency co-ordination, clean-up and repair) can be significant. Increased budget pressure to adapt to impact of climate change, e.g. flood protection measures and upgrading of existing drainage systems. 	Moderate
	Reputational	<ul style="list-style-type: none"> Pluvial flooding issues are localised but can result in short term impact on public opinion. 	Minor
 <p>River flood Common</p>	Assets	<ul style="list-style-type: none"> River flooding has resulted in the temporary inundation of buildings. Storm Barra in 2021 caused flooding in parts of Donegal town when the River Eske burst its banks. River flooding results in transport disruption and road closures. Heavy rainfall and coastal flooding in July 2022 caused a section of the Sli na Sliante path to collapse. River flooding/fast flowing rivers can damage bridges through hydrodynamic scour. The parapet on a bridge near Redcastle on the R238 collapsed following build-up of water in July 2022. Storm Lorenzo in 2019 caused substantial damage to a footbridge over the Glen River in Carrick. In December '15, during Storm Desmond a number of properties were flooded in Lifford, including council offices. 	Major
	Health and Wellbeing	<ul style="list-style-type: none"> Heavy precipitation and floodwater leads to dangerous driving conditions for both council staff and public. Fluvial floods can carry debris which can lead to injury of residents and pedestrians. Heavy rainfall and extensive flooding resulted in a landslide to occur on the road between Muff and Bunrana in Aug '17, putting the homes of nearby residents at risk and causing the road to become completely impassable. 	Moderate
	Environment	<ul style="list-style-type: none"> River flooding can result in the overland flow of pollutants (nutrients, sediment and pesticides) with impacts on terrestrial and freshwater ecosystems. In August 2019, warning notices were put in place at Lisfannon, Lady's Bay, Bundoran and Fintra beaches due to the risk of heavy rainfall causing agricultural runoff carried by rivers to threaten bathing waters. 	Moderate
	Social	<ul style="list-style-type: none"> Road closures can result in significant social isolation for communities. Flooding in Glenswilly in Sep '22, caused residents to be trapped in their homes for two days. In August '17, approx. 30 homes were flooded in the Lios na Greíne and Páirc an Ghrianáin areas of Burnfoot, with at least 7 businesses also affected. Approximately €570k was paid to 300 farmers in the Inishowen area to fix flood damage caused in August '17. Damage included loss of livestock, loss and damage of hay silage, repair of damaged agricultural lands, and repair of damaged fencing. 	Moderate
	Cultural Heritage	<ul style="list-style-type: none"> A number of the county's cultural heritage and archaeological sites are situated near river systems and are particularly exposed to river flooding. 	Minor
	Financial	<ul style="list-style-type: none"> The financial implications of fluvial flooding are associated with increased costs associated with preparedness (e.g., sandbags and demountable defences), emergency response (e.g. pumping and emergency co-ordination), clean-up and repair. 	Minor
Reputational	<ul style="list-style-type: none"> For areas that are subject to frequent inundation, there is the potential for localised short term impact on public opinion. 	Minor	

3.2.3 Impact Assessment (Service Delivery)

Summary of Service Level Impacts

Key to colour coding of impact ratings
Catastrophic
Major
Moderate
Minor
Negligible

The impacts of climate change hazards on County Donegal will have direct and indirect consequences for the delivery of services by Donegal County Council before, during and after climate and weather-related event.

On the basis of reported information and in consultation with Donegal County Council, an assessment of the impacts of identified climate change hazards and impacts on the delivery of services by Donegal County Council was undertaken in accordance with the criteria provided through Technical Annex B: Climate Change Risk Assessment (Appendix 2), with each service delivery area assigned an impact category of either negligible, minor, moderate, major, or catastrophic.

Below we provide a summary of the impacts on the delivery of services of Donegal County Council as a result of the climate hazards identified within the climate hazard profile. This assessment was undertaken in accordance with the criteria provided through **Technical Annex B: Climate Change Risk Assessment (see appendix 1)**, with each service delivery area assigned an impact category of either negligible, minor, moderate, major, or catastrophic. The following pages provide the detailed information that informed this assessment.

Hazard	Internal LA Governance & Administration	Roads, Transportation & Critical Infrastructure Services	Built Environment & Asset Management Services	Community Development Services / Economic & Tourism Development Services	Arts, Culture & Heritage Services	Water Supply Services	Environment Services (Protection & Enhancement)	Emergency Services & Response
Heatwave	Minor	Moderate	Minor	Minor	Minor	Moderate	Moderate	Moderate
Drought	None	None	None	Moderate	Minor	Moderate	Minor	Minor
Cold Spell	Moderate	Moderate	Moderate	Moderate	Minor	Moderate	Moderate	Moderate
Heavy Snowfall	Moderate	Major	Moderate	Moderate	Minor	Minor	Moderate	Moderate
Severe Windstorm	Moderate	Major	Moderate	Moderate	Moderate	Moderate	Moderate	Major
Coastal Flood	Minor	Moderate	Minor	Moderate	Moderate	Moderate	Moderate	Moderate
Coastal Erosion	None	Minor	None	None	None	None	Minor	None
Pluvial Flood	Minor	Moderate	Minor	Minor	Minor	Minor	Moderate	Minor
River Flood	Moderate	Major	Moderate	Moderate	Minor	Minor	Minor	Major

*Delivered through a Service Level Agreements (SLA) with Irish Water

Service Level Impacts (Heatwaves & Drought)

Heatwaves and drought result in a range of impacts for service provision by Donegal County Council. The primary impacts relate to increased maintenance and repair requirements of road surfaces and increased pressure on emergency response as a result of the increased incidence of uncontrolled fire. Decreased levels of water supply due to drought conditions put increased pressure on LA staff working under the Service Level Agreement (SLA) with Irish water. In addition, high temperatures result in staff and public discomfort and an increased requirement for mechanical and passive cooling. Heatwaves and drought put additional pressure on community infrastructure such as parks.

Key to colour coding of impact ratings

Catastrophic
Major
Moderate
Minor
Negligible

	Heatwaves	Drought
Internal LA Governance & Administration	<ul style="list-style-type: none"> Decreased staff productivity and increased staff and customer discomfort. 	<ul style="list-style-type: none"> None
Roads, Transportation & Critical Infrastructure Services	<ul style="list-style-type: none"> Increased costs associated with repair of road surfaces across the county. Increased health and safety risk for outdoor staff members across the county. 	<ul style="list-style-type: none"> None
Built Environment & Asset Management Services	<ul style="list-style-type: none"> Increased requirement for cooling in council offices/buildings. 	<ul style="list-style-type: none"> None
Community Development Services / Economic & Tourism Development Services	<ul style="list-style-type: none"> Increased requirement for waste collection and traffic management at key recreational sites. 	<ul style="list-style-type: none"> Reduced grass growth causing increased supplementary feed requirement for cattle reducing farm incomes and the wider industry.
Arts, Culture & Heritage Services	<ul style="list-style-type: none"> Increased requirements for monitoring and maintenance of cultural heritage sites. Increased staff and customer discomfort. 	<ul style="list-style-type: none"> Localised degradation of cultural heritage sites due to drying out. Increased requirements for monitoring and maintenance of cultural heritage sites.
Water Supply Services	<ul style="list-style-type: none"> Increased demand for water to cool infrastructure, communities, and livestock. Implementation of water conservation measures (e.g., hosepipe bans). 	<ul style="list-style-type: none"> Increased requirement to support provision of water to communities suffering loss of water supply (e.g., Tankering).
Environment Services (Protection & Enhancement)	<ul style="list-style-type: none"> Reduced water flows impacting on water quality across county with increased requirement for monitoring and remediation. Decreased ecosystem health across the county with potential for loss of priority habitats resulting in increased requirement for monitoring and remediation. 	<ul style="list-style-type: none"> Reduced water flows impacting on water quality in local areas with increased requirement for monitoring and remediation. Reduced water flows impacting on biodiversity with potential for loss of priority species and habitats necessitating increased monitoring and remediation.
Emergency Services & Response	<ul style="list-style-type: none"> Increase in number of wildfire call-outs across the county. Increase in number of call out to bathing areas throughout the county. 	<ul style="list-style-type: none"> Increase in number of uncontrolled fire call-outs at a localised level.
Crosscutting	<ul style="list-style-type: none"> Health and Safety of Staff 	

Service Level Impacts (Cold Spell & Heavy Snowfall)

Cold spells and heavy snowfall have significant impacts across County Donegal with direct and indirect consequences for the delivery of services by Donegal County Council. Impacts are related primarily to maintenance and repair of assets and infrastructure, closure of local authority offices and services, and increased demand on emergency response.

Key to colour coding of impact ratings

Catastrophic

Major

Moderate

Minor

Negligible

	Cold Spell	Heavy Snowfall
Internal LA Governance & Administration	<ul style="list-style-type: none"> Closure of business services across the county. Health and safety risks for public and staff. 	<ul style="list-style-type: none"> Closure of business services across the county. Health and safety risks for public and staff.
Roads, Transportation & Critical Infrastructure Services	<ul style="list-style-type: none"> Increased costs associated with gritting and salting roads across the county. Increased road repair and maintenance costs. Reduced capacity for drainage resulting in standing water due to post cold spell events. Damage to stormwater infrastructure with increased requirement for maintenance and repair across the county. Damage to wastewater infrastructure with increased requirement for maintenance and repair. 	<ul style="list-style-type: none"> Transport disruption and road closures. Increased costs associated with gritting and salting roads and footpaths around the county. Increased road repair and maintenance costs.
Built Environment & Asset Management Services	<ul style="list-style-type: none"> Increased energy costs for buildings county wide. Increased health and safety risks for public and staff county wide. 	<ul style="list-style-type: none"> Increased energy costs for buildings county wide. Increased health and safety risks for public and staff county wide.
Community Development Services / Economic & Tourism Development Services	<ul style="list-style-type: none"> Increased energy costs in community buildings across the county. Increased health and safety risks for public and staff working in community buildings. Increased instances of county wide community isolation. 	<ul style="list-style-type: none"> Increased health and safety risks for public and staff. Closure of services throughout communities across the county. Increased instances of county wide community isolation.
Arts, Culture & Heritage Services	<ul style="list-style-type: none"> Increased energy costs for cultural heritage sites. Increased health and safety risks for public and staff at community heritage sites. 	<ul style="list-style-type: none"> Increased health and safety risks for public and staff. Localised closure of sites.
Water Supply Services	<ul style="list-style-type: none"> County wide water supply issues due damaged water supply infrastructure (e.g., burst pipes). Increased maintenance and repair costs of water service infrastructure across the county. Overland flows of pollutants due to post freezing events, causing contamination of water supplies necessitating increased monitoring and remediation. 	<ul style="list-style-type: none"> Localised water supply issues due damaged water supply infrastructure (e.g., burst pipes). Increased maintenance and repair costs of water service infrastructure.
Environment Services (Protection & Enhancement)	<ul style="list-style-type: none"> Overland flows of pollutants due to post freezing flood events resulting in decreased water quality necessitating increased requirement on council for monitoring. Prolonged cold spells impacting species not protected from the frigid temperatures in local communities requiring increased monitoring and remediation. 	<ul style="list-style-type: none"> Overland flows of pollutants due to post freezing flood events resulting in decreased water quality necessitating increased requirement on council for monitoring. Heavy snowfall impacts species not protected from the frigid temperatures, with increased monitoring and remediation required at a county wide level.
Emergency Services & Response	<ul style="list-style-type: none"> Increased pressure on emergency response units across the county. Increase in response time due to treacherous road conditions around the county. 	<ul style="list-style-type: none"> Increased pressure on emergency response units across the county. Increase in response time due to heavy snowfall on roads around the county.
Crosscutting	<ul style="list-style-type: none"> Redeployment of staff 	

Service Level Impacts (Severe Windstorm)

Severe windstorms can result in the closure and/or disruption of Donegal County Council Offices and Services. Primary impacts of severe windstorms are associated with disruption of services and infrastructure due to loss of power supply and communications, damage to local authority assets and infrastructure, increased pressure on emergency response and redeployment of staff to support clean-up following a severe windstorm event.

Key to colour coding of impact ratings

Catastrophic

Major

Moderate

Minor

Negligible

	Severe Windstorm
Internal LA Governance & Administration	<ul style="list-style-type: none"> Widespread closure of business services. Health and safety risks for public and staff.
Roads, Transportation & Critical Infrastructure Services	<ul style="list-style-type: none"> County wide transport disruption and road closures affecting the wider community and local authority operations. Increased clean-up and repair costs after an event. Increased drain maintenance costs for wastewater infrastructure at a widespread level. Disruption of critical infrastructure services (e.g. electricity) impacting on wastewater treatment.
Built Environment & Asset Management Services	<ul style="list-style-type: none"> Closure of buildings and disruption of services as a result of direct damage to buildings and disruption of power and communications.
Community Development Services / Economic & Tourism Development Services	<ul style="list-style-type: none"> Disruption to delivery of community services across the county. Increased clean-up and repair costs after an event. Increased power outages and damages to infrastructure result in an impact on local economy.
Arts, Culture & Heritage Services	<ul style="list-style-type: none"> Closure of sites and events. Increased maintenance and repair costs due to storm damage to cultural heritage sites.
Water Supply Services	<ul style="list-style-type: none"> Water supply issues due to damaged water supply infrastructure.
Environment Services (Protection & Enhancement)	<ul style="list-style-type: none"> High winds result in damage to habitats. Increased cost to protect habitats from wind damage.
Emergency Services & Response	<ul style="list-style-type: none"> Widespread increased pressure on emergency service.
Crosscutting	<ul style="list-style-type: none"> Staff redeployment

Service Level Impacts (Coastal Flood & Erosion)

Coastal flooding result in a range of impacts for service provision by Donegal County Council. Impacts of coastal flooding are associated with clean-up and repair costs, damage to assets and infrastructure and damage to environmentally sensitive areas. Coastal erosion has limited impact on service provision by Donegal County Council with impacts primarily associated with damages to transport infrastructure, detrimental impacts on coastal habitats and increased requirement for their monitoring and remediation.

Key to colour coding of impact ratings
Catastrophic
Major
Moderate
Minor
Negligible

	Coastal Flood	Coastal Erosion
Internal LA Governance & Administration	<ul style="list-style-type: none"> Temporary inundation of buildings in exposed area resulting in closure of services. 	<ul style="list-style-type: none"> None
Roads, Transportation & Critical Infrastructure Services	<ul style="list-style-type: none"> Transport disruption and road closures across the county. Increased clean-up and repair costs. Damage to stormwater systems with increased requirement for maintenance and repair. Damage to wastewater infrastructure with increased requirement for maintenance and repair. 	<ul style="list-style-type: none"> Transport disruption and road closures. Maintenance and repair costs.
Built Environment & Asset Management Services	<ul style="list-style-type: none"> Inundation of building stock. 	<ul style="list-style-type: none"> None
Community Development Services / Economic & Tourism Development Services	<ul style="list-style-type: none"> Damage to community infrastructure such as parks and refuse collection points. Closure of community infrastructure and services. Increased repair and maintenance costs. Inhibited development of communities at risk of coastal flooding. 	<ul style="list-style-type: none"> None
Arts, Culture & Heritage Services	<ul style="list-style-type: none"> Damage to heritage sites exposed to coastal flooding across the county. Increased health and safety risks. Increased maintenance and repair costs. 	<ul style="list-style-type: none"> None
Water Supply Services	<ul style="list-style-type: none"> Damage to critical water supply infrastructure with increased requirement for maintenance and repair. 	<ul style="list-style-type: none"> None
Environment Services (Protection & Enhancement)	<ul style="list-style-type: none"> Impact on the water status of high quality sites necessitating increased monitoring and remediation. Damage to coastal habitats resulting in a decrease of ecosystem health at a county wide level and an increased requirement for monitoring and remediation. 	<ul style="list-style-type: none"> Damage to coastal habitats resulting in a decrease of ecosystem health at a localised level and an increased requirement for monitoring and remediation.
Emergency Services & Response	<ul style="list-style-type: none"> Increased pressure on emergency response units across the county. 	<ul style="list-style-type: none"> None
Crosscutting	<ul style="list-style-type: none"> Staff redeployment 	

Service Level Impacts (Pluvial & River Flood)

Pluvial and river flooding have resulted in a wide range of impacts for Donegal County Council. Impacts are primarily associated with clean-up and repair costs, water quality issues due to overland flows of pollutants into water courses, damage to environmentally sensitive areas, increased pressure on emergency response services and supporting communities during and following flood events.

Key to colour coding of impact ratings

Catastrophic
Major
Moderate
Minor
Negligible

	Pluvial Flood	River Flood
Internal LA Governance & Administration	<ul style="list-style-type: none"> Localised disruption and closure of local authority services. 	<ul style="list-style-type: none"> Disruption and closure of local authority services.
Roads, Transportation & Critical Infrastructure Services	<ul style="list-style-type: none"> County wide transport disruption and road closures. Increased clean-up and repair costs after an event. Reduced capacity for drainage resulting in standing water. Damage to stormwater infrastructure across the county. Damage to wastewater treatment plants. 	<ul style="list-style-type: none"> Transport disruption and road closures. Increased clean-up and repair costs after an event. Reduced capacity for drainage resulting in standing water. Damage to stormwater infrastructure at a county wide level.
Built Environment & Asset Management Services	<ul style="list-style-type: none"> Damage to buildings and disruption of service at localised level. Increased maintenance and repair costs. Increased requirement for flood defence measures. 	<ul style="list-style-type: none"> Damage to buildings and disruption of service across the county. Increased maintenance and repair costs. Increased requirement for flood defence measures.
Community Development Services / Economic & Tourism Development Services	<ul style="list-style-type: none"> Closure of community infrastructure and services at a localised level. Increased repair and maintenance costs. Inhibited development of communities at a localised level. Damage to buildings and travel disruptions impact on local economies. 	<ul style="list-style-type: none"> County wide closure of community infrastructure and services. Increased repair and maintenance costs. Inhibited development of communities across the county. Damage to buildings and travel disruptions impact on local economies.
Arts, Culture & Heritage Services	<ul style="list-style-type: none"> Damage to heritage sites due to pluvial flooding requiring repair work. Increased maintenance and repair costs. 	<ul style="list-style-type: none"> Damage to heritage sites due to river flooding requiring repair work. Increased maintenance and repair costs.
Water Supply Services	<ul style="list-style-type: none"> Water supply issues at a localised level requiring supplemental water provision (e.g., tankering). Increased water treatment costs due to contamination by overland pollutant flows. 	<ul style="list-style-type: none"> Water supply issues at a localised level requiring supplemental water provision (e.g., tankering). Increased water treatment costs due to contamination by overland pollutant flows.
Environment Services (Protection & Enhancement)	<ul style="list-style-type: none"> Deterioration of water quality due to overland flow of pollutants resulting in water supply issues and environmental degradation and an increased requirement for monitoring and remediation. Severe damage across the county to environmentally sensitive areas requiring monitoring and/or restoration work. 	<ul style="list-style-type: none"> Deterioration of water quality due to overland flow of pollutants resulting in water supply issues and an increased requirement for monitoring and remediation. Isolated and limited damage to environmentally sensitive areas requiring monitoring and/or restoration work.
Emergency Services & Response	<ul style="list-style-type: none"> Localised increased pressure on emergency response. 	<ul style="list-style-type: none"> Increased pressure on emergency response.
Crosscutting	<ul style="list-style-type: none"> Staff redeployment 	

3.2.4 Current Climate Risk Matrix

Current Climate Risk Matrix

Based on reported information and in consultation with Donegal County Council, a current climate risk matrix for County Donegal has been developed based on the frequency of hazard and the associated level of impact.

The assessment identified **severe windstorm** as posing the highest level of risk for County Donegal with impacts primarily associated with disruption and damage to energy, communication and transport networks.

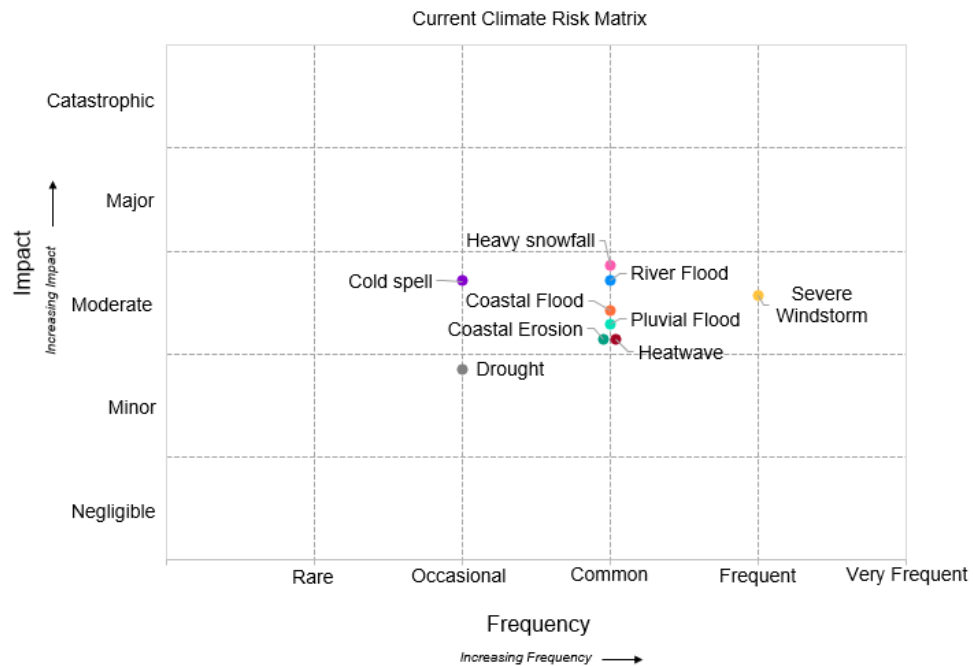
Heavy snowfall is considered a risk for County Donegal with moderate impact. The impacts of heavy snowfall are associated with disruption of transport infrastructure, damages to critical energy, communication and water infrastructure. **River and coastal flooding** have been identified as posing a relatively high risk for County Donegal with impacts experienced including damage to assets and infrastructure and potential for isolation of communities and vulnerable populations.

Pluvial flooding is also considered a risk for County Donegal with impacts associated with damages to road surfaces, disruption of transport networks and mobilisation of pollutants.

Coastal erosion along the Donegal coastline is ongoing, and has significant impacts on coastal assets and infrastructure and cultural heritage sites. **Heatwaves** occur on a common basis across County Donegal with moderate impact. The impacts of heatwaves are associated with an increase in the frequency of uncontrolled fire, damage to road surfaces and increased pressure on recreational sites.

Cold spells occur on an occasional basis across County Donegal resulting in damages to critical energy, communication and water infrastructure while closure of transport infrastructure has the potential to result in isolation of remote communities..

During the current period, **Droughts** have occurred on occasional basis but with relatively minor impacts and are associated with increases in the frequency of uncontrolled fires and disruption of water supply.



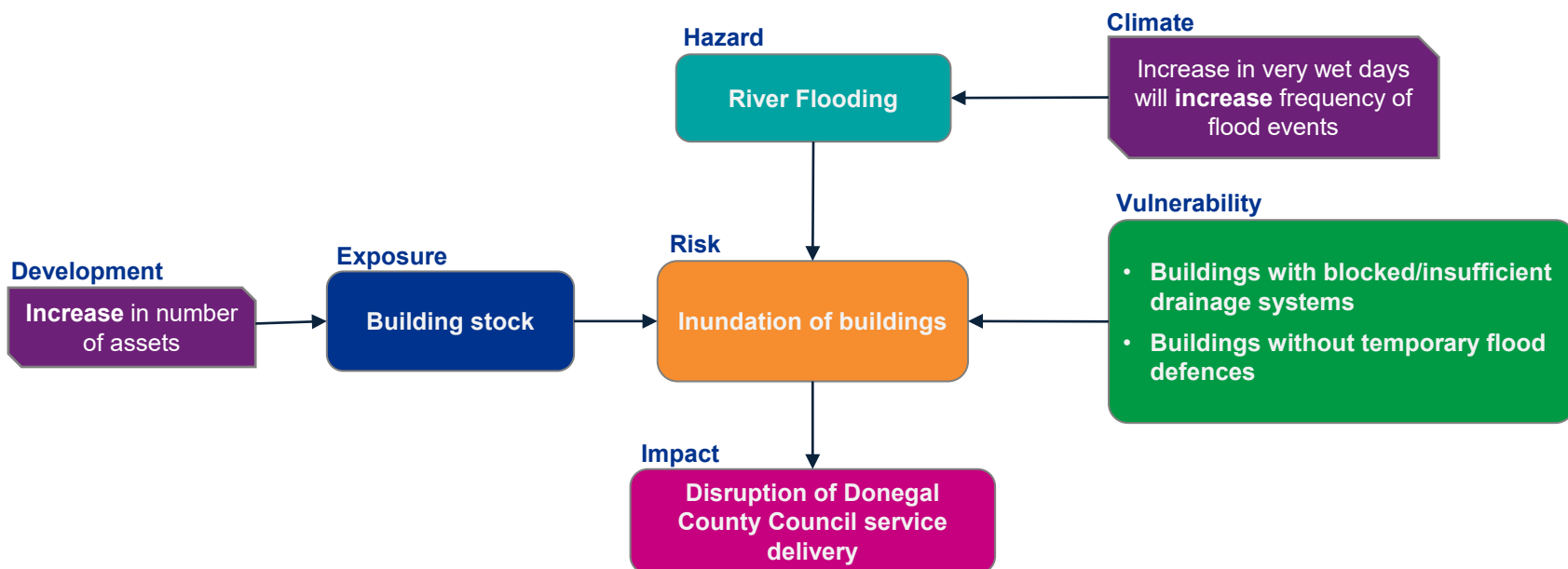
The risk matrix above shows the current risk for the identified hazards within County Donegal.

3.3 Future Climate Risks and Impact Assessment

Future Climate Risk and Impact

Climate risks may increase, decrease, or emerge in the future due to a change in either the frequency and severity of climate hazards and/or changes in exposure and vulnerability. In the example below, the risk of inundation due to river flooding will increase due to an increase in the number of very wet days (> 30 mm precipitation) leading to an increase in the frequency of river flood events. Furthermore, there is likely to be an increased population in the region, possibly resulting in new buildings being constructed. This will potentially increase the number of assets exposed to river flooding. Therefore, due to changes in both the hazard and exposure, the risk of inundation of Donegal County Council buildings will increase in the future.











In the following sections, we provide an assessment of potential future changes in the climate of County Donegal by 2050 and its effects on the frequency of hazard occurrence. An assessment of the future changes in the population and development in the region by 2050 that could affect exposure and vulnerability was also undertaken. Finally, considering all three components, the future climate risk was assessed.

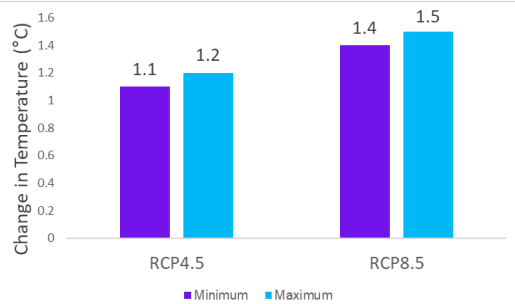


3.3.1 Future Changes in Climate Hazards

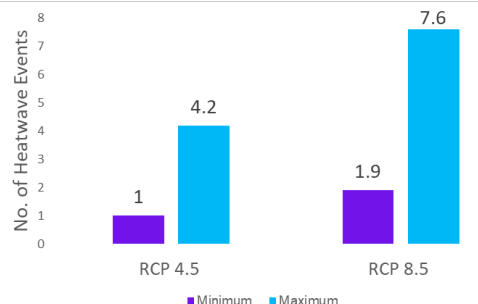
Climate Projections for County Donegal in 2050 (1/2)

Having identified and assessed the range of climate hazards and impacts already experienced by Donegal County Council, the projected changes in the frequency and intensity of climate hazards (acute and chronic) were assessed to understand how existing climate impacts and risks faced by Donegal County Council may be exacerbated. The information below summarizes the climate projections for each hazard based on Nolan and Flanagan (2020).

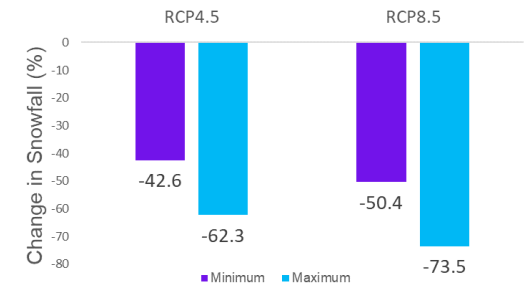
Hazard	Projected Change	Future Frequency
 Heatwaves	<ul style="list-style-type: none"> Projections indicate an overall increase in average temperature (bottom left) of between 1.1 and 1.5°C for County Donegal relative to the 1981-2000 period. Under a high emission scenario, projections indicate that heatwaves will become more frequent (bottom middle) by mid-century. 	Frequent 
 Droughts	<ul style="list-style-type: none"> Summer rainfall is expected to reduce in the future when compared with the baseline period of 1981 to 2000, in both the RCP4.5 and RCP8.5 scenario contributing to potential drought conditions. 	Common 
 Cold Spell	<ul style="list-style-type: none"> As a consequence of the increasing temperatures, a decrease in the number of frost days and ice days is projected for the 2041-2060 period when compared with the baseline period of 1981 to 2000, for both the RCP4.5 and RCP8.5 scenario. 	Rare 
 Heavy Snowfall	<ul style="list-style-type: none"> The annual snowfall in the region is projected to decrease substantially by the middle of the century for the RCP4.5 and RCP8.5 scenarios (bottom right). 	Occasional 
 Severe Windstorms	<ul style="list-style-type: none"> Projections of storms are subject to a high level of uncertainty. By mid century, projections indicate that average wind speed will remain similar to those currently experienced. There is limited evidence of a potential increase in the frequency of more intense storms which are currently rare events. However, more research is needed to confirm this increase. 	Frequent 



The projected minimum and maximum **increase in the mean annual temperature** for the area of County Donegal for the period 2041-2060 compared to 1981-2000 for a medium (RCP4.5) and high (RCP8.5) emissions scenario (Source: Nolan and Flanagan, 2020)











The projected minimum and maximum **number of heatwaves** for the area of County Donegal for the period 2041-2060 compared to 1981-2000 for a medium (RCP4.5) and high (RCP8.5) emissions scenario (Source: Nolan and Flanagan, 2020)

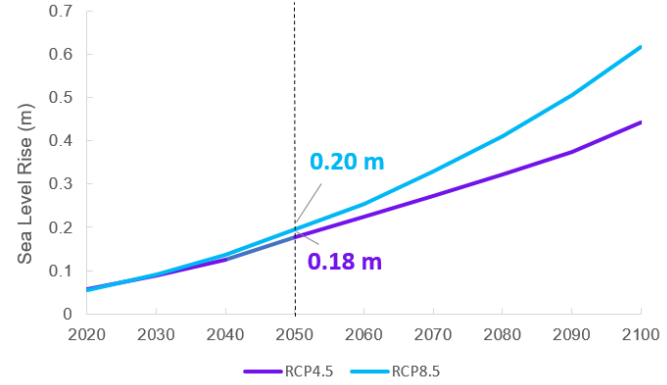


The projected minimum and maximum **reduction in snowfall** for the area of County Donegal for the period 2041-2060 compared to 1981-2000 for a medium (RCP4.5) and high (RCP8.5) emissions scenario (Source: Nolan and Flanagan, 2020)

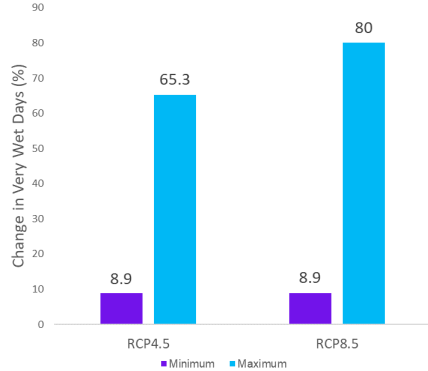
Climate Projections for County Donegal in 2050 (2/2)

Having identified and assessed the range of climate hazards and impacts already experienced by Donegal County Council, the projected changes in the frequency and intensity of climate hazards (acute and chronic) were assessed to understand how existing climate impacts and risks faced by Donegal County Council may be exacerbated. The information below summarizes the climate projections for each hazard based on Nolan and Flanagan (2020).

Hazard	Projected Change	Future Frequency
 Coastal Flooding	<ul style="list-style-type: none"> Rising sea levels projections under a high emissions scenario indicate an increase of up to 0.20 m by 2050 which will increase the frequency of coastal inundation (bottom left). 	Frequent 
 Coastal Erosion	<ul style="list-style-type: none"> A rising sea level is strongly linked with coastal erosion and an increase in erosion rates and extent. 	Frequent 
 Pluvial Flooding	<ul style="list-style-type: none"> Projections indicate an increase in the frequency of heavy rainfall days (days with precipitation >30mm) for County Donegal with some areas projected to see increase of up to 80% (bottom right). This will likely result in an increased frequency of associated fluvial and pluvial flooding. 	Frequent 
 River Flooding		Frequent 



Projected **change in sea level** for a medium (RCP4.5) and high (RCP8.5) emissions scenario offshore of County Donegal (Grid Reference: 53,-10) (Source: IPCC AR6 Sea-Level Rise Projections)



The projected minimum and maximum **increase in very wet days (> 30 mm)** for the area of County Donegal for the period 2041-2060 compared to 1981-2000 for a medium (RCP4.5) and high (RCP8.5) emissions scenario (Source: Nolan and Flanagan, 2020)

3.3.2

Future Changes in Exposure and Vulnerability (incl. Emerging Risk)

Projected Changes in Exposure and Vulnerability

In the future, County Donegal will also change in terms of its population and developments with implications for levels of exposure and vulnerability across the region. National, regional and local strategies that outline expected and possible sociodemographic and infrastructure developments within County Donegal were reviewed to understand how exposure and vulnerability may change by 2050. A summary of the results of this review are shown below.



How is Ireland projected to change by 2040?

- Extra **1m population**, 500,000 in rural areas / regional centres
- Extra 660,000 jobs

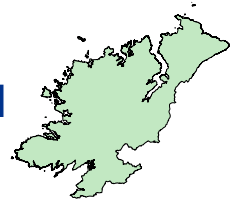


- Extra **550,000 homes**
- 'Housing for All' promotes a 'town centre first' approach

Cross-Sectoral National Priorities:

- Infrastructure and Services
- Climate Change Adaptation & Mitigation
- Regeneration, Repopulation, Resilience

How is County Donegal projected to change?



- Population to increase from 159,200 in 2016 to **c.176,500 in 2028** (NPF)
- Letterkenny **population targeted to increase by 8,000** between 2016 and 2040. (RSES)
- **5,613** new housing units required by 2028. (DHLGH HND A Toolkit)

RSES Objectives: "at least 30% of all new homes that are targeted in settlements with a population of at least 1,500..., within the existing built-up footprints."

Planning for adaptation



Flood Defence Schemes:
The Office of Public Works-Council projects include **Raphoe Flood Relief Scheme** which aims to protect 387 properties. The project's public consultation has now been completed.

- Recent national road infrastructure projects focus for council include:**
- N15/N13 Ballybofey to Stranorlar Bypass
 - N56/13 Letterkenny to Manorcunningham
 - N14/15/A5 Link

Notable renewable energy initiatives include:



- 27 X Sustainable Energy Community (SEC) (e.g. The Dolmen Eco-Tourism Centre, Glenalla SEC and Moville SEC)
- Wind Farms (e.g. existing Meenadreen and Meentycat wind farms)
- Solar farms applications (e.g. Ard na Ceapairí in Bunbeg, West Donegal)

Planning for mitigation

Case Study in Urban Planning: Letterkenny 2040 Regeneration Strategy

Letterkenny 2040 sets out detailed design concepts for 11 key regeneration sites and initiatives across the town centre. It is funded by the Urban Regeneration and Development Fund (URDF), a flagship initiative of Project Ireland 2040 and match funded by Donegal County Council. Phase 1 of has received **€13.60 million** in funding.

The strategy includes a 'wetlands proposal' (i.e. to redevelop a town area prone to flooding into a major park), a diverse development at Lower Main Street (incl. town centre homes, Creative Enterprise Hub, urban parkland to enhance the Cathedral Quarter), development of a Regional Transport Hub along Pearse Road connected to public realm and walking and cycling infrastructure.

Future Exposure and Vulnerability (1/2)

In addition to the changes in the frequency of hazard events, future risk is also driven by the changes in exposure and vulnerability. In order to estimate the potential change in risk, a number of assumptions have been made in relation to the seven impact areas, which are outlined below.

<h2>Assets</h2>	<ul style="list-style-type: none"> • Due to the expected increase in County Donegal’s population, there will be an increase in the associated households and infrastructure resulting in an increase in the number of assets exposed to hazard events • Due to the expected increase in the frequency of heatwaves, road assets will be more regularly exposed to extreme temperatures and drought conditions with the potential for increased damage to roads • Pluvial and river flooding events that were once considered extreme, will become more frequent. This will increase damage in the areas already exposed to these hazards and also expose new areas and therefore assets that were previously unaffected
<h2>Health and Wellbeing</h2>	<ul style="list-style-type: none"> • Due to the expected increase in the elderly population in County Donegal there will be a greater number of vulnerable people who are more sensitive to hazards, particularly heatwaves • Pluvial and river events that were once considered extreme, will become more frequent. Consequently, people will be more frequently exposed to flooding hazards, and higher flood levels which will mean people previously unaffected by flooding may become exposed. This could impact on both physical and mental health and wellbeing
<h2>Environment</h2>	<ul style="list-style-type: none"> • The potential increasing occurrence of heatwaves and drought conditions within County Donegal will mean increased temperatures in water bodies and lower water levels which can decrease water quality resulting in short and long term impacts on the environment • Due to the potential increased frequency of exposure to hazards in County Donegal, there could be an increase in the impact on environmental assets as the time/ability for the habitat/environment to recover is reduced • Pluvial and river flooding events that were once considered extreme, will become more frequent. Consequently, environmental assets will be more frequently exposed to flooding hazards, and higher flood levels will mean environmental assets previously unaffected by flooding may become exposed- resulting in short and long term damage to habitats/environment by these hazards

Future Exposure and Vulnerability (2/2)

In addition to the changes in the frequency of hazard events, future risk is also driven by the changes in exposure and vulnerability. In order to estimate the potential change in risk, a number of assumptions have been made in relation to the seven impact areas, which are outlined below.

Social	<ul style="list-style-type: none"> • Due to the expected increase in the total and elderly population in County Donegal there will be an increase in the number of people affected by social isolation during some hazard events • In response to heatwaves, there will be an increased use of blue/green spaces by the public putting increased pressure on local amenities e.g. littering, traffic problems
Cultural Heritage	<ul style="list-style-type: none"> • Due to the potential increase in frequency of heatwave and drought events, degradation rates will potentially increase resulting in an increase in the impact of cultural heritage assets • Pluvial and river flooding events that were once considered extreme, will become more frequent. Consequently, cultural heritage assets will be more frequently exposed to flooding hazards, and higher flood levels will mean cultural heritage assets previously unaffected by flooding may become exposed resulting in short and long term damage to habitats/environment by these hazards
Financial	<ul style="list-style-type: none"> • Due to the potential increase in frequency of hazard events and exposure across County Donegal, there will be an associated increase in the actions the local authority takes before, during, and after an event • As a consequence, there will be an increase in the costs associated with dealing with the events, e.g. air conditioning, emergency service response, temporary and permanent flood defences, staff, training, and equipment purchase/maintenance
Reputational	<ul style="list-style-type: none"> • Due to the potential increase in frequency of hazard events and exposure across County Donegal during an event there will be an increase in demand/pressure on services/resources potentially reducing the level of service delivery and harming the reputation of the local authority • For hazards which are existing long-term issues in County Donegal, e.g. river flooding, if the response to the increased frequency and severity events is deemed insufficient by the public, this may negatively impact on the reputation of the local authority

Future Impacts

Taking into account the changes in exposure and vulnerability, the future change in impacts for each of the nine hazards was assessed. The potential future changes in impact are outlined below with the change in impact shown in bold.

Hazard	Assets		Health and Wellbeing		Environment		Social		Cultural Heritage		Financial		Reputational	
	Current	Future (2050)	Current	Future (2050)	Current	Future (2050)	Current	Future (2050)	Current	Future (2050)	Current	Future (2050)	Current	Future (2050)
Heatwave	Moderate	Major	Negligible	Minor	Moderate	Major	Minor	Moderate	Minor	Moderate	Minor	Moderate	Minor	Moderate
Drought	Minor	Moderate	Negligible	Minor	Moderate	Major	Minor	Moderate	Minor	Moderate	Minor	Moderate	Negligible	Minor
Cold Spell	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minor	Minor	Moderate	Moderate	Minor	Minor
Heavy Snowfall	Major	Major	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minor	Minor	Moderate	Moderate	Minor	Minor
Severe Windstorm	Major	Major	Moderate	Moderate	Minor	Minor	Minor	Minor	Minor	Minor	Moderate	Moderate	Minor	Minor
Coastal Flood	Moderate	Major	Minor	Moderate	Moderate	Major	Minor	Moderate	Minor	Moderate	Moderate	Major	Minor	Moderate
Coastal Erosion	Minor	Moderate	Negligible	Negligible	Moderate	Major	Minor	Moderate	Moderate	Major	Minor	Moderate	Minor	Moderate
Pluvial Flood	Moderate	Major	Minor	Moderate	Minor	Moderate	Minor	Moderate	Minor	Moderate	Moderate	Major	Minor	Moderate
River Flood	Major	Major	Moderate	Major	Moderate	Major	Moderate	Major	Minor	Major	Minor	Moderate	Minor	Moderate

3.3.3 Future Climate Risk Matrix

Future Climate Risk Matrix

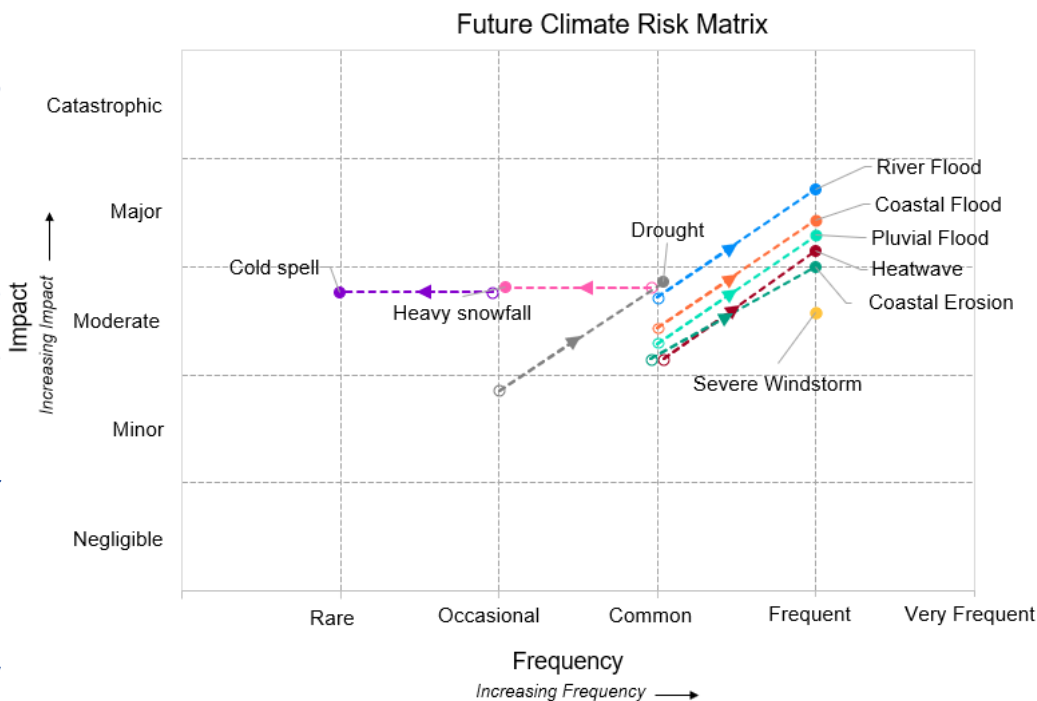
Projected changes in levels of hazard, exposure, and vulnerability for County Donegal combine to form an assessment of future risks. The future climate risk matrix on the right shows projected change in risk with the hollow marker showing the current risk and the solid marker the future risk. The dotted line shows the change between the current and future risk.

The **risk** of existing hazards such as **river, pluvial, heatwave, coastal flooding and erosion** is projected to **increase** in the future as a result of projected increases in the frequency of hazard events and also due to an increase in the areas, assets and populations exposed to these hazards.

Droughts although already experienced in County Donegal, are expected to occur more frequently due to climate change and with a greater impact on County Donegal in the future. The risk is exacerbated by not only projected changes in the frequency of drought but also as a result of projected population increases and in the proportion of the population considered vulnerable (those aged 65 years and over). Droughts can therefore be considered as **emerging risk** for the region.

Although the frequency and impact of **severe windstorms** is thought to be **unchanged in the future**, these events will remain a risk for County Donegal.

The impact of **heavy snowfall and cold spells** on County Donegal remains constant, however, due to the potential decrease in hazard frequency, the overall risk of these hazards is projected to reduce in the future, resulting in less risk.



The risk matrix above shows the future changes in risk for the identified hazards within County Donegal. For each hazard there is a solid marker, which identifies the future risk, and a hollow marker showing the current risk. The dotted line in between these markers shows the change between the current and future risk.

3.3.4 Uncertainty Assessment

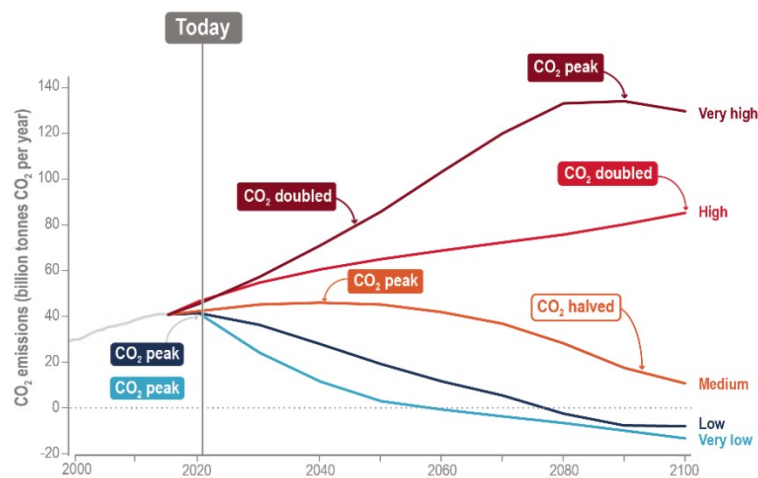
Uncertainty

In assessing future climate risks there are levels of uncertainty related to each of the three elements of risk, i.e., not only the magnitude and frequency of hazards but also the exposure and vulnerability to any given hazard.

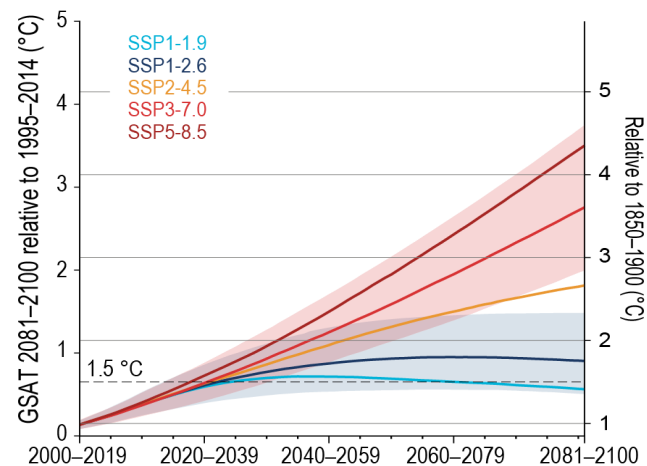
Different social and economic developments can lead to substantially different future emissions of carbon dioxide and other greenhouse gases (bottom left) resulting in uncertainty in what the future global climate will be. As an example of the possible future ranges in mean global surface temperature (bottom right) vary from below 1.5°C to over 4°C by 2100.

As a result of this uncertainty, climate projections include a range of scenarios, with SSP5-8.5 (AR6) or RCP8.5 (AR5) being the highest emission scenario and therefore the greatest change in future climate. When assessing climate risks with a qualitative approach, it is best practice to take a conservative or 'worst case scenario' to ensure that climate risks are not underestimated and dismissed as low or no risk. Climate risks identified within a qualitative risk assessment should be subsequently assessed using semi-quantitative or quantitative approaches to evaluate the risk in further detail.

Uncertainty also exists in relation to how County Donegal will develop into the future. Although, in the near-term there is relatively good understanding as a result of strategies, such as the Donegal County Development Plan 2022-2028, developments up to 2050 are less certain. A 'worst case scenario' approach has been taken here also, with the potential future impact being increased according to the indicative near-term trend and the assumption that adaptation actions are not implemented.



Annual emissions of CO₂ for the five core Shared Socio-economic Pathway (SSP) scenarios (very low: SSP1-1.9, low: SSP1-2.6, intermediate: SSP2-4.5, high: SSP3-7.0, very high: SSP5-8.5) (Source: IPCC AR6 Infographic TS.1).








Assessed projected change in mean global surface temperature for five future climate scenarios. Future global temperatures can vary from below 1.5°C to over 4°C by 2100 depending on the amount of future emissions (Source: IPCC AR6 Cross-Chapter Box TS.1, Figure 1).

3.4 Summary

Summary

This CCRA detailed within this report provides an assessment of County Donegal's climate risks to support Donegal County Council's efforts to prepare its LACAP. The CCRA has been carried out in line with the Local Authority Climate Action Plan Guidelines, Technical Annex B, drafted by the Climate Action Regional Offices (CAROs). The key results are summarised below:

- 
 - Recent experiences of **river** and **pluvial flooding** events (e.g., 2018, 2019 and 2022) have resulted in damages to buildings, and infrastructure, disruption of transport networks (Sli na Sliante path), and impacts on business (New Row in Donegal town) and local economy. Projected increases in the frequency of extreme precipitation events will result in increased surface water and riverine flood risk for County Donegal.
- 
 - **Coastal erosion** and **coastal flooding** already pose a significant risk for County Donegal and have resulted in temporary inundation of buildings, loss of transport infrastructure, damage to water treatment and wastewater infrastructure. Rising sea levels will increase the rate of coastal erosion and frequency of coastal inundation, resulting in an increased coastal erosion and flood risk for County Donegal.
- 
 - **Severe windstorms** are currently experienced on a frequent basis in County Donegal and result in wide-ranging impacts, including disruption to energy supply, communications infrastructure and transport networks. Projections indicate no significant change to this frequency.
- 
 - County Donegal experienced both a **heatwave** and **drought** in 2018, with heatwaves also recorded in 2021 and 2022. These events resulted in damage to road surfaces (e.g. boiling tar in Killyclug), increased demand placed on water resources (hosepipe ban) and recreational areas and detrimental impacts on freshwater quality and fish populations. Projected increases in the frequency of heatwaves and drought conditions will mean that events currently experienced on an infrequent basis will become more frequent.
- 
 - Recent experiences of **cold spells** and **heavy snowfall** events in 2018 (e.g. Storm Emma) demonstrated the wide range of impacts for County Donegal. These included, amongst others, increase in the frequency of trips and falls, disruption to road networks, power outages and impacts on water resources and on business and local economy. Projected increases in average temperature and decreases in the frequency of snowfall indicate a decrease in the frequency of cold spells, heavy snowfall, and their associated impacts

To increase resilience, Donegal County Council will need to proactively plan for and adapt to the current and future climate change risks identified through this CCRA.

04

Appendices



4.1

Appendix 1

Glossary

Biodiversity: The variability among living organisms from terrestrial, marine and other ecosystems. Biodiversity includes variability at the genetic, species and ecosystem levels

Climate: The long-term average weather of area, usually taken over 30 years

Climate projection: A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models

Coastal erosion is the breaking down of land and removal of sediment and rocks by coastal processes. Factors affecting the rate of coastal erosion include sea level rise, strong wave action, and storms

Cold Spell: A sustained period of cold weather, where extreme low temperatures are recorded

Coastal Flooding: Coastal flooding occurs when sea levels along the coast or in estuaries exceed neighbouring land levels, or overcome coastal defences where these exist, or when waves overtop over the coast

Drought: A period of abnormally dry weather long enough to cause a serious hydrological imbalance

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

Extreme weather event: An extreme weather event is an event that is rare at a particular place and time of year

Fluvial flooding occurs when rivers and streams break their banks and water flows out onto the adjacent low-lying areas (the natural floodplains)

Groundwater flooding occurs when the water table rises above the land surface. It generally requires sustained rainfall over relatively longer duration than other forms of flooding, its location is discontinuous, and they can last for weeks or months

Glossary

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

Heat wave: A period of abnormally and uncomfortably hot weather

Heavy Snowfall: A substantial prolonged snowfall event resulting in substantial accumulations of snow on the ground over a period of consecutive days

Landslide describes a wide variety of processes that result in the downward and outward movement of materials under the force of gravity

Pluvial flooding occurs when the amount of rainfall exceeds the capacity of urban storm water drainage systems or the ground to absorb it

Representative Concentration Pathways (RCPs): 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

RCP4.5 and RCP6.0: Two intermediate stabilization pathways in which radiative forcing is stabilized at approximately 4.5 W/m² and 6.0 W/m² after 2100 (the corresponding ECPs assuming constant concentrations after 2150)

RCP8.5 One high pathway for which radiative forcing reaches >8.5 W/m² by 2100 and continues to rise for some amount of time (the corresponding ECP assuming constant emissions after 2100 and constant concentrations after 2250)

Risk: The potential, when the outcome is uncertain, for adverse consequences on something of value (lives, ecosystems, assets, services, etc.)

Severe Windstorm: A windstorm is a wind that can cause at least light damage to trees and buildings, typically exceeds 34 mph (55 km/h), and may or may not be accompanied by rain

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt

4.2

Appendix 2

Service Area Descriptions

Acronym	Full form
Business Services	Corporate and customer facing services.
Roads, footpaths, bridges, construction and maintenance	Road and active travel, bridges, piers and harbours.
Building Stock	Local Authority buildings and social housing stock.
Community infrastructure	Recreation (incl. libraries and parks), tourism and economic development infrastructure.
Cultural Heritage	Arts and heritage protection.
Stormwater / Sewerage	Stormwater and sewerage infrastructure.
Wastewater	Foul and surface water sewers, water treatment plants and wastewater pumping stations.
Water Supply	Public water supply network (with Irish Water), public water treatment plant and pumping stations (with Irish Water) .
Water Quality	Water quality (rivers, lakes and marine).
Biodiversity	Biodiversity and habitat protection.
Community Development	Community development and co-ordination.
Emergency Response	Fire and water safety services, emergency response during severe weather response.

Acronyms

Acronym	Full form
CAPS	Climate Action Plans
CAROs	Climate Action Regional Offices
CCRA	Climate Change Risk Assessment
CDP	County Development Plan
CRA	Climate Risk Assessment
EPA	Environmental Protection Agency
EU	European Union
GHG	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change
LA	Local Authority
NHA	National Heritage Area
RCP	Representative Concentration Pathways

Description of the levels of impact due to disruption of Local Authority Services (Source: Technical Annex B: Climate Change Risk Assessment)

Impact	Description	Level of Impact
Catastrophic	Widespread service failure with services unable to cope with wide-scale impacts	5
Major	Services seen to be in danger of failing completely with severe widespread decline in service provision	4
Moderate	Service provision under severe pressure. Appreciable decline in service provision at community level	3
Minor	Isolated but noticeable examples of service decline	2
Negligible	Appearance of threat but no actual impact on service provision	1

Characterisation of the magnitude of impact across various risk areas (Source: Technical Annex B: Climate Change Risk Assessment)

Risk Area	Negligible (Score; 1)	Minor (Score: 2)	Moderate (Score: 3)	Major (Score: 4)	Catastrophic (Score:5)
Asset Damage	Impact can be absorbed through normal activity	An adverse event that can be absorbed by taking business continuity action	A serious event that requires additional emergency business continuity actions	A critical event that requires extraordinary/ emergency business continuity actions	Disaster with the potential to lead to shutdown or collapse or loss of assets/ network
Health and Wellbeing	First aid case	Minor physical injury or mental health impact, medical treatment required	Serious physical or mental health impact, or lost work	Major or multiple injuries or mental health impact, permanent or physical disability	Single or multiple fatalities
Environment	No impact on baseline environment. Localised in the source area. No recovery required	Localised within site boundaries. Recovery measurable within one month of impact	Moderate harm with possible wider effect. Recovery in one year	Significant harm with local effect. Recovery longer than one year. Failure to comply with environmental regulations/ consent	Significant harm with widespread effect. Recovery longer than year. Limited prospect of full recovery
Social	No negative social impact.	Localised, temporary social impacts	Local, long-term impact on public opinion with adverse local media coverage	Failure to protect poor or vulnerable groups. National, long-term social impacts	Loss of social licence to operate. Community protests
Financial (for single extreme event or annual average impact)	x % IRR < 2% of turnover	x % IRR 2- 10% of turnover	x % of IRR 10-25% of turnover	x % IRR 25-50% of turnover	x % IRR > 50% of turnover
Reputation	Localised, temporary impact on public opinion	Localised, short-term impact on public opinion	Local, long-term impact on public opinion with adverse local media coverage	National, short-term impact on public opinion; negative media coverage	National, long-term impact with potential to affect stability of the government
Cultural Heritage	Insignificant impact	Short term impact. Possible recovery or repair	Serious damage with wider impact to tourism industry	Significant damage with national and international impact	Permanent loss with resulting impact on society

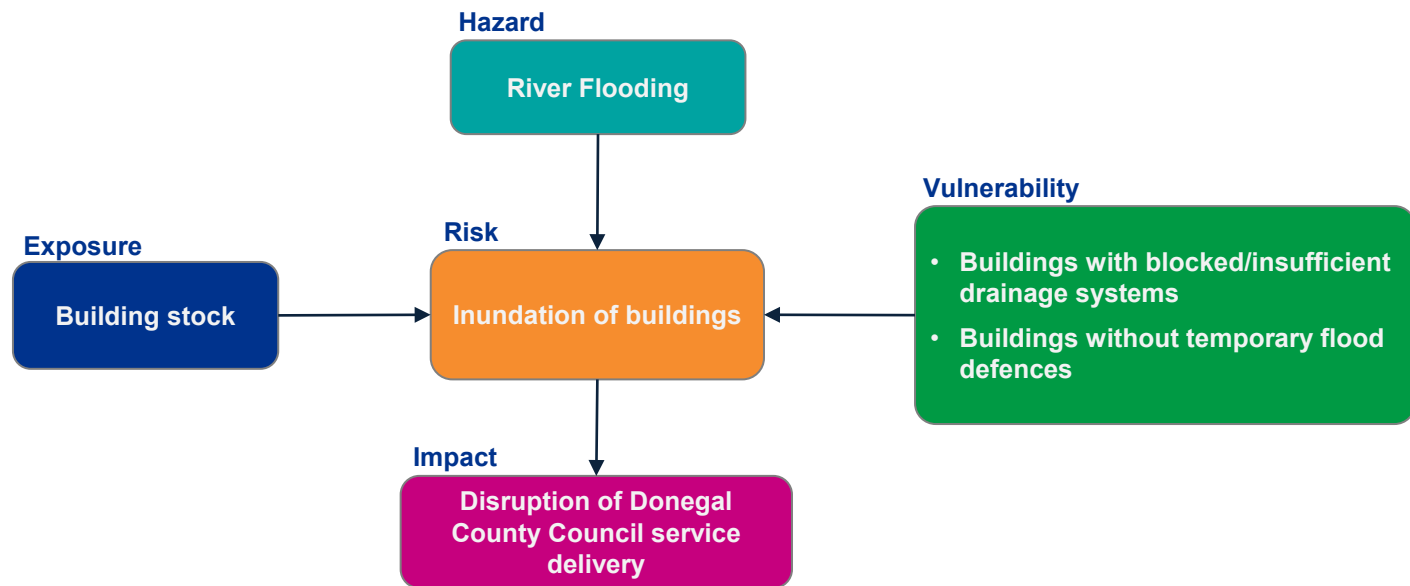
4.3

Appendix 3

Characterising Exposure, Vulnerability and Impacts of Climate Hazards

For County Donegal and for each of the identified climate hazards, we characterised the exposures, vulnerabilities, and impacts associated with the relevant hazard events. For example, below shows the three risk components for a river flooding hazard which would pose an inundation risk to Donegal County Council buildings. The buildings with insufficient drainage and with no temporary flood defences would be considered more vulnerable to this hazard. Consequently, if Donegal County Council buildings were to be flooded, one of the possible impacts would be the disruption of Donegal County Council's ability to deliver its services. This process was undertaken for each hazard and a range of exposures were identified along with their associated vulnerabilities.

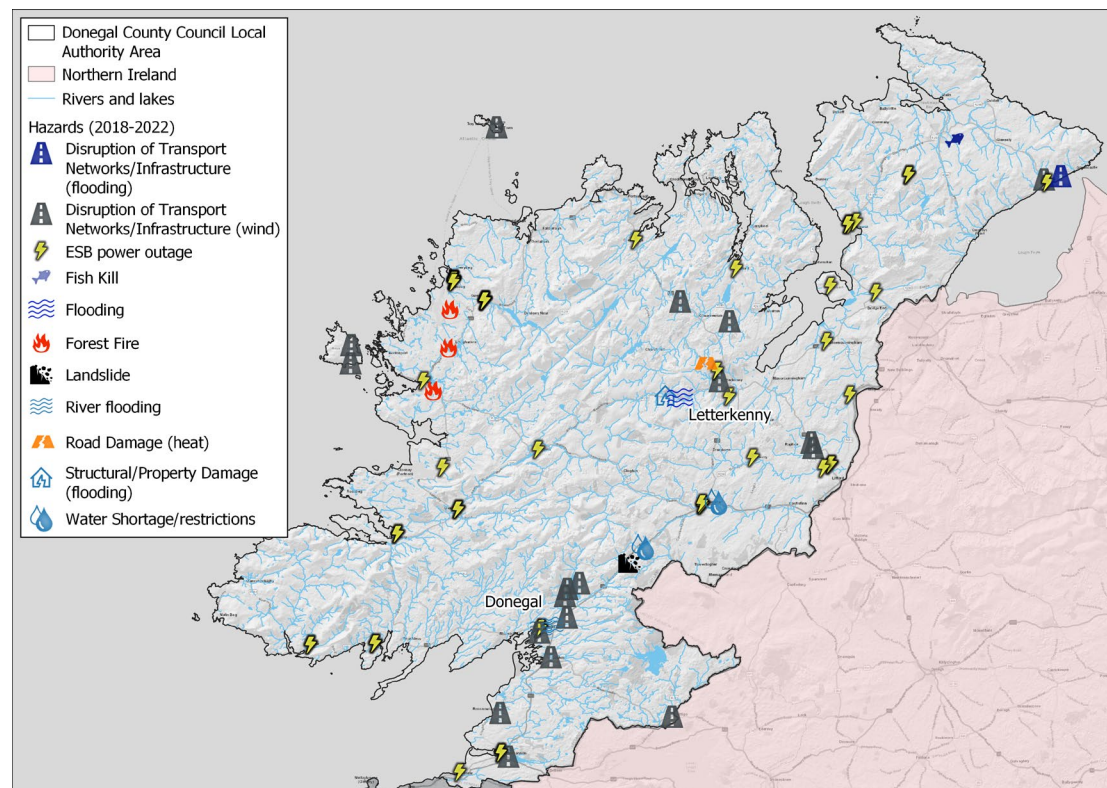
The following pages summarise the exposures, vulnerabilities and impacts for the hazards that exist within the County Donegal region.



Exposure, Vulnerability and Impacts of Climate Hazards

Employing and integrating information derived a wide range of sources, we have characterised the exposures, vulnerabilities, and impacts of the climate and weather-related hazards for County Donegal. Below and to the right we provide an example of exposures and impacts of hazard events experienced between 2018 and 2022.

- **Heavy rainfall** led the R250 in Glenswilly to be flooded several times in September and October 2022, blocking access to residents' homes. Flood prevention works cost €120,000.
- **Heavy rainfall** in July 2022 caused damage to a bridge in the R238, as well as the collapse of a section of the Sli na Sliante path near Moville.
- **Storm Gareth** in 2019 led to the cancellation of ferry services to Toragh and delays to the ferry service to Árainn Mhór.
- Dry weather followed by heavy rainfall led to a **massive landslide** at Meenbog wind farm in December 2020, causing a significant ecological disaster, harming spawning grounds for Salmon in the Mournebeg river and leading to preliminary stabilisation costs of €25,000.
- **Cold weather** in December 2022 led to broken pipes, difficulties replenishing reservoirs, and water restrictions being placed on homes in the Lough Mourne Water Scheme.
- In August 2022, **high water temperatures led to a fish kill event** involving over 2,250 juvenile brown trout and Atlantic salmon in the Glengannon river at Inishowen.
- A 1 in a 100 year rainfall event (63 mm of rainfall in an 6 hour period) caused the Burnfoot River to burst its banks in August 2017, leading to the R238 bridge to become impassable, along with 30 homes and 7 businesses becoming inundated.



Impacts of climate hazards (1/5)

The table below shows the key impacts and exposures associated with each climate and weather-related hazard. Detailed information on exposure specific vulnerabilities (physical, social and environmental) are provided in the associated impacts and risks spreadsheet.

Hazard	Key Impacts	Key Exposures (and Key Vulnerabilities)
Heatwave	<ul style="list-style-type: none"> • Hot and uncomfortable working/living conditions • Increased demand on recreational areas • Disruption of public transport networks • Damage to road surface and hazardous driving conditions • Heat stress for animals and livestock • Increased frequency of beach/swimming area closures • Increased demand on available water resources, leading to increasing pressure to share resources • Detrimental impacts on freshwater quality and fish populations • Disruption of recreational activities • Increased strain on natural biodiversity • Increase in the frequency of uncontrolled fire 	<ul style="list-style-type: none"> • Housing, buildings (including LA offices), care home/leisure centres/ recreational facilities, outdoor workers (with lack of access to water, shade and sunscreen) • Beaches, parks (with easy access to urban areas) • Public/ staff (communities with limited transport network) • Local roads (surface-dressed roads, located in areas of high solar radiation) • Livestock (farms with limited watering infrastructure, with lack of shade) • Beaches/swimming areas (heavily utilised, with low access to shade) • Reservoirs/lakes (lakes already depleted/under stress) • Fish populations (sites with deteriorated water quality/eutrophic status) • Recreational areas (situated in areas of high solar radiation) • European / Irish designated sites (SPAs, SACs, Ramsar sites, NHAs) • Emergency response services (areas of growing vegetation)
Drought	<ul style="list-style-type: none"> • Decreased grass growth and increased supplementary feed requirements for cattle • Increased demand on available water resources, leading to increasing pressure to share resources • Increased degradation rates • Reduced river flow 	<ul style="list-style-type: none"> • Livestock (marginal farm incomes) • Reservoirs/lakes/groundwater supplies (lakes already depleted/under stress) • Cultural heritage • Biodiversity (areas with diverse wildlife populations)

Impacts of climate hazards (2/5)

The table below shows the key impacts and exposures associated with each climate and weather-related hazard. Detailed information on exposure specific vulnerabilities (physical, social and environmental) are provided in the associated impacts and risks spreadsheet.

Hazard	Key Impacts	Key Exposures (and Key Vulnerabilities)
Cold Spell	<ul style="list-style-type: none"> • Extreme cold results in increased requirement for heating and associated economic costs • Cold conditions resulting in increased damage to vehicles • Disruption to road networks • Disruption to public transport networks • Cold conditions leading to damage of road surfaces (i.e., freeze thaw) • Increase in the frequency of trips and falls • Reduction in agricultural production • Difficulties in accessing land • Freeze thaw damage to critical water infrastructure • Impacts on water resources • Increased strain on natural biodiversity • Damage to built heritage • Damage and disruption of electricity supply • Increases in cold-related mortality and morbidity • Delay of infrastructure/development projects 	<ul style="list-style-type: none"> • Buildings (poorly insulated, with elderly residents, in isolated locations) • Public/private transport vehicles (exposed vehicles) • Transport network (untreated road surfaces, near isolated communities) • Public/staff (Isolated and vulnerable communities, elderly populations) • Road network (roads at higher elevations) • Public/staff (elderly populations, people with pre-existing conditions) • Crops, livestock (cold-sensitive crops, areas with low solar radiation) • Land (marginal farms, areas of low solar radiation) • Water infrastructure/pipes (older pipes, in areas of freezing soil conditions) • Water resources (waterbodies in lower altitudes) • European / Irish designated sites (SPAs, SACs, Ramsar sites, NHAs) • Built heritage (built heritage in more exposed locations) • Homes/businesses/local govt office/agricultural sites (energy users which are connected to the distribution network and without on-site generation and storage.) • People at high risk of exposure to cold (people in insulated buildings, vulnerable communities) • Development projects (ongoing construction with loose materials)
Heavy Snowfall	<ul style="list-style-type: none"> • Damage to buildings • Disruption of transport network • Disruption of public transport network • Freezing conditions impacting on livestock • Disruption to energy/electricity supply • Impact on business and local economy • Disruption to waste collection • Runoff from snow melt impacting on environmentally sensitive areas • Snow melt resulting in increased risk of flooding 	<ul style="list-style-type: none"> • Buildings (vacant/flat roof properties, higher elevation, with elderly residents), offices (incl. LA) (higher elevation, impervious surfaces) • Local authority offices • Public/staff (communities with limited access, elderly and young populations) • Agricultural sites (livestock unprotected) (farms at higher elevations, marginal farms) • Energy (energy infrastructure in need of maintenance, older infrastructure) • Employers, employees, customers, students (business in low-lying areas, lacking remote work/study options, etc.) • Natural resources/sensitive materials (env. sensitive areas, networks with polluting vehicles, near waterbodies) • Areas prone to flooding(areas prone to pooling of water, inadequate drainage) • Transport networks (in terrain with a with higher propensity of snow drifts, isolated roads)

Impacts of climate hazards (3/5)

The table below shows the key impacts and exposures associated with each climate and weather-related hazard. Detailed information on exposure specific vulnerabilities (physical, social and environmental) are provided in the associated impacts and risks spreadsheet.

Hazard	Key Impacts	Key Exposures (and Key Vulnerabilities)
<p>Severe Windstorm</p>	<ul style="list-style-type: none"> • Direct wind damage to buildings and infrastructure • Disruption of communications infrastructure • Wind damage to habitats and sensitive species • Wind damage to trees resulting in tree fall • Treacherous conditions at coast and on land • Disruption of wind energy generation • Disruption to energy supply • Accessibility of islands communities • Disruption to waste collection • Disruption to water quality monitoring • Disruption of transport networks • Closure of parks and public buildings 	<ul style="list-style-type: none"> • Buildings, development sites (buildings w. rooftop equip., vulnerable populations, high-rise structures) • Overhead communication lines (situated in upland and exposed sites) • Habitats and sensitive species (habitats and tree species already under stress) • Trees (forestry situated in upland and /or exposed areas) • Coastal and upland areas (areas in exposed locations) • Wind turbines (turbines with lower shut-down thresholds for high winds) • Power supply (infrastructure in exposed locations, vulnerable populations, isolated communities) • Island communities (exposed locations) • Waste collection routes (routes in exposed locations) • Waterbodies (water bodies in need of water quality monitoring) • Road network (in exposed locations) • Parks (isolated communities) • Public buildings (populations requiring essential council services, exposed locations)

Impacts of climate hazards (4/5)

The table below shows the key impacts and exposures associated with each climate and weather-related hazard. Detailed information on exposure specific vulnerabilities (physical, social and environmental) are provided in the associated impacts and risks spreadsheet.

Hazard	Key Impacts	Key Exposures (and Key Vulnerabilities)
Coastal Flood	<ul style="list-style-type: none"> • Temporary inundation of buildings • Deterioration of transport infrastructure • Closure/submergence of transport routes and impact on commuting, accessibility and travellers • Treacherous conditions at coast and on land • Damage to recreational amenities and facilities provided by the council • Damage to and erosion of coastal habitat • Flooding of agricultural areas • Accessibility of islands communities • Damage to critical water supply infrastructure • Damage to water treatment and wastewater infrastructure 	<ul style="list-style-type: none"> • Housing buildings, heritage sites (located in low lying coastal areas) • Coastal road infrastructure (roads situated in low-lying coastal areas) • Coastal areas (coastal low-lying amenity areas exposed to storms) • Footpaths, parks and recreational amenities (amenities not served by suitable drainage which are in proximity to bodies of water and sensitive to storms) • Coastal habitat (sites exposed to coastal storms) • Agricultural areas (farms on marginal income) • Island transport infrastructure (habitable island areas without safe harbours) • Water infrastructure/pipes • Wastewater treatment plants (water restrictions, boil water notices and bathing water notices)
Coastal Erosion	<ul style="list-style-type: none"> • Deterioration of transport and subterranean infrastructure • Disruption and loss of transport infrastructure • Erosion of agricultural areas • Damage to recreational amenities • Damage to coastal habitat • Damage to heritage sites 	<ul style="list-style-type: none"> • Coastal roads and rail infrastructure (road and rail situated in low-lying coastal areas) • Public/staff (roads used for commuting purposes and by isolated communities and students) • Agricultural areas (low-lying coastal areas) • Recreational amenities (amenities not served by suitable coastal protection measures and sensitive to erosion) • Coastal habitat (sites exposed to existing coastal erosion) • Heritage sites (environmentally sensitive areas - terrestrial and aquatic (e.g. Ramsar sites))

Impacts of climate hazards (5/5)

The table below shows the key impacts and exposures associated with each climate and weather-related hazard. Detailed information on exposure specific vulnerabilities (physical, social and environmental) are provided in the associated impacts and risks spreadsheet.

Hazard	Key Impacts	Key Exposures (and Key Vulnerabilities)
Pluvial Flood	<ul style="list-style-type: none"> • Direct rain and surface water damage to buildings and infrastructure • Damage to amenities and recreational areas • Pluvial debris • Disruption of public transport networks • Disruption of transport Networks/Infrastructure • Surface water (run-off) pollutants • Impact on business and local economy 	<ul style="list-style-type: none"> • Buildings, local authority offices, heritage sites (blocked drainage systems, high levels of impervious surfaces, etc) • Recreational amenities (low-lying parks and other amenities, located near water bodies such as lakes and rivers) • People (beaches, riversides and parks - especially ones located near sources of debris) • Stormwater Infrastructure (areas where there is a lot of un-reinforced waste management systems containing potential debris (natural/man-made)) • Public/Staff (transport infrastructure with limited surrounding drainage and signage made of sensitive materials) • Road (transport infrastructure with limited surrounding drainage and signage made of sensitive materials) • Natural resources/sensitive materials (enviro. sensitive areas, heavily fertilised agric. land close to water bodies), wastewater treatment infrastructure • Employers, employees, customers, students (business in low-lying areas, lacking remote work/study options, etc.)
River Flood	<ul style="list-style-type: none"> • Flood damage to buildings and infrastructure • Damage to amenities and recreational areas • Fluvial debris • Disruption of transport networks/Infrastructure • Surface water (run-off) pollutants • Impact on business and local economy • Damage/degradation to automobiles and public transport • Potential bridge failure • Inundation of farmland 	<ul style="list-style-type: none"> • Buildings, local authority offices, heritage sites (blocked drainage, loc. on floodplains, vulnerable residents) • Recreational amenities (low-lying parks, located near water bodies, parks and amenities in need of investment) • Stormwater infrastructure, people (river banks and parks which lack man-made/natural drainage- especially ones located near sources of debris) • Road/railways (low lying roads/railways, located near water bodies, limited drainage) • Natural resources/sensitive materials (env. sensitive areas, networks with polluting vehicles, near waterbodies) • Employers, employees, customers, students (located in at-risk areas, lack of access to early warning systems) • Council fleets, public transport, private vehicles (underground/low-lying car parks, fleets sensitive to submergence) • Bridges (older bridges, bridges in need of investment and maintenance) • Farmland situated on riverbanks (farmlands situated in close proximity to rivers and on flood plain)



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