Wicklow County Council

Climate Change Risk Assessment

LACAP

Final Report

5th May 2023

Comhairle Contae Chill Mhantáin
Wicklow County Council

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Executive Summary

Context and Scope of this Report

Climate change poses a critical challenge for County Wicklow. It will result in a wide range of impacts across the county, from damaging infrastructure such as roads and railway, to detrimental impacts on biodiversity and limiting water supply. These impacts will bring substantial implications for Wicklow 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.

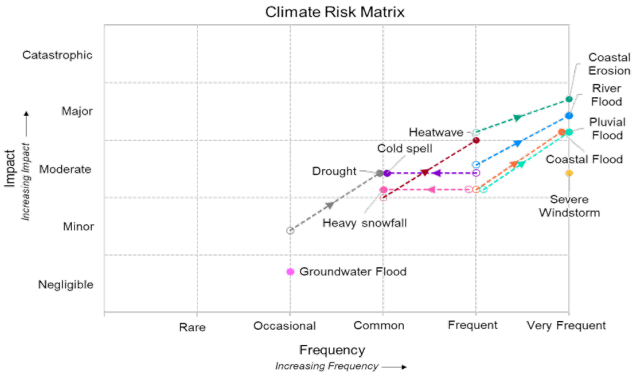
This report provides an assessment of potential climate change risks for Wicklow and the impacts of these for the delivery of services by Wicklow County Council. The aim of the report is to provide the evidence base to inform the development of the LACAP for Wicklow County Council.

Key Results and Findings

As illustrated in the climate risk matrix on the right, the level of risk posed by some hazards (e.g. coastal erosion and flooding, river and pluvial flooding, heatwaves and drought) is projected to increase while others will remain the same (e.g. severe windstorms and groundwater flooding). Some hazards are expected to decrease in frequency, such as cold spells and heavy snowfalls.

- **Coastal erosion and flooding** pose a significant risk for County Wicklow and have resulted in damage to and loss of transport infrastructure (e.g. the eastern rail corridor), loss of coastal habitat (e.g. the Murrough), disruption of recreational infrastructure (e.g. Greystones to Bray Head), and inundation of buildings. 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 Wicklow.
- Recent experiences of **river and pluvial flooding** events in 2020, 2021 and 2022, resulted in inundation of buildings, disruption of transport networks (e.g. M11), increased pressure on emergency services, and the imposition of 'do not swim notices' due to decreased bathing water quality. Projected increases in the frequency of extreme precipitation events will result in increased surface water and riverine flood risk for County Wicklow.
- **Severe windstorms** are currently experienced on a frequent basis in County Wicklow and result in wide-ranging impacts, including damage to buildings and infrastructure, disruption to energy supply, and disruption of transport networks. Projections indicate no significant change to this frequency.
- County Wicklow experienced both a **heatwave and drought** in 2018, and 2022, with heatwaves also recorded in 2021. These events contributed to the ignition of uncontrolled fires (e.g. Liffey Head and Lough Bray), placed an increased demand on water resources, put increased pressure on recreational areas, and had detrimental impacts on freshwater quality (e.g. Blessington Lakes algal blooms). 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 Wicklow. These included, amongst others, disruption and damage to road networks (e.g. Sally Gap and N81), disruption of energy supply, impacts on water resources (e.g. boil water notices), and widespread business and economic impacts. 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.
- **Groundwater flooding** is currently experienced on an infrequent basis in County Wicklow and results in limited impacts. Projections indicate no significant change to this frequency.

To increase resilience, Wicklow 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 Wicklow. 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.

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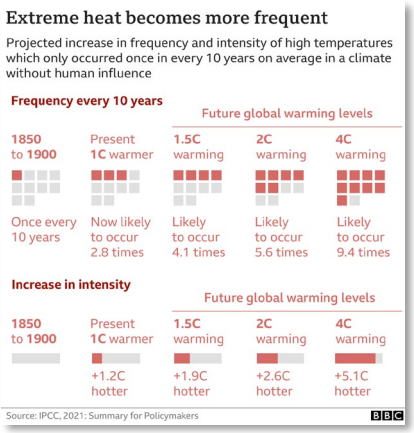
02

Introduction

Global Response to the Challenge of Climate Change

Global Climate Change Challenge



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 trends

Climate relates to average weather over a period of time, which is typically measured over 20 or 30 years.

Local impacts

Weather relates to short term changes in atmospheric conditions and can change from minute-to-minute, day-to-day and season-to-season.

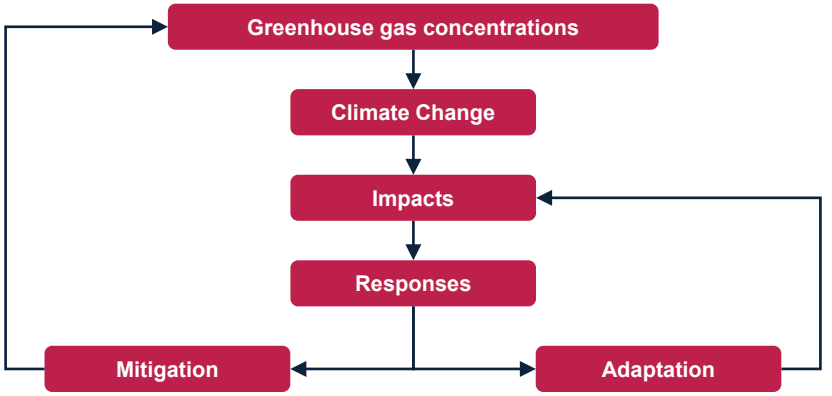
It is becoming apparent that **changes in global climate are being reflected in changes in the frequency and intensity of extreme weather events such as heatwaves, droughts and flooding.**

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.



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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 climate change is 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.

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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

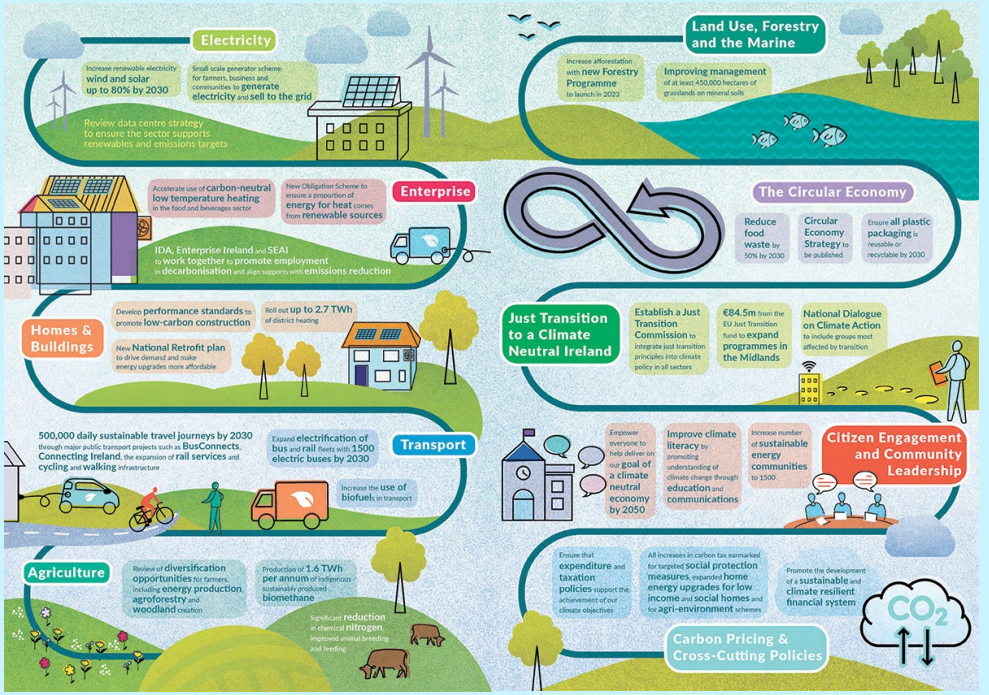
The EU adopted a legislative proposal for the European Climate Law in June 2021 to frame the climate neutrality objective by 2050 across the EU with an intermediate target of **reducing net greenhouse gas emissions by at least 55% by 2030**. The European Commission (EC) is clear in the commitment required 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



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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 Local Authority Climate Action Plan (LACAP) Guidelines (2023).

These guidelines structure the development and implementation of LACAP around a 4-step cycle, which is supported by four technical annexes[1]:

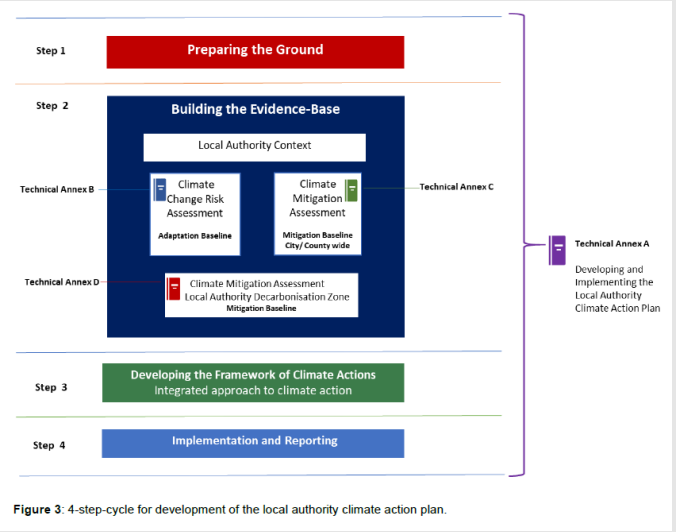

Figure 3: 4-step-cycle for development of the local authority climate action plan.

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

Scope of this report

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

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03

Climate Change Risk Assessment Methodology

3.1 Introduction, Scope and Methodology

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Understanding of Climate Change Risk Assessment

Purpose of Climate Change Risk Assessment

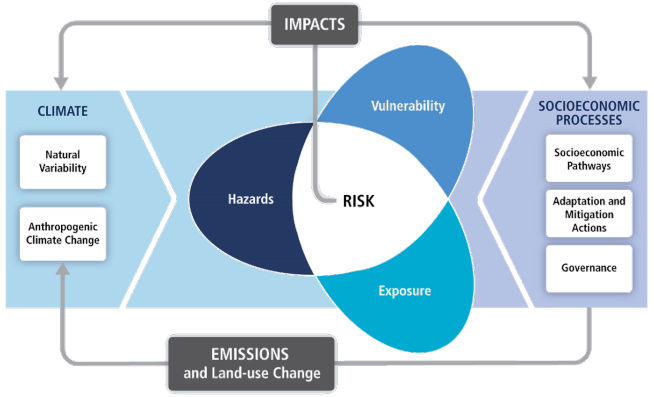
Responding to climate change impacts involves taking adaptation actions to reduce the adverse risks posed by current and projected climate change.

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 County Wicklow, 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.



Hazard: potential source of climate-related harm, i.e., damage or loss of property.

Exposure: presence of people, livelihoods, environmental services and resources, infrastructure, or economic and social or cultural assets in places that could be adversely affected.

Vulnerability: propensity / disposition to be adversely affected.

Risk: the potential for adverse consequences.

Anthropogenic Climate Change

Impact of human activity on climate; more specifically, the global warming caused by human-induced GHG emissions resulting in an enhanced greenhouse effect and increased global temperatures.

Natural Variability

Natural variability refers to the variation in global climate caused by non-human activities such as long term shifts in weather patterns.

Adaptation & Mitigation Actions

Adaptation actions aim to reduce adverse climate impact and risks.

Mitigation actions refer to those that address the causes of anthropogenic climate change.

Governance

Looks at how governance factors, e.g. Institutions, transparency, policies, etc. contribute or hinder adaptation or mitigation measures.

Socio-economic pathways

Looks at how changes in socio-economic factors, e.g. wealth & inequality, demographics, access to technology, etc. impact and contribute to mitigation and adaptation action.

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

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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 Wicklow.

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

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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 Wicklow
- 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

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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 Wicklow and the consequence of these for Wicklow 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 Wicklow.

We have updated the climate hazard profile developed through the existing Wicklow 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 Wicklow

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

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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 Wicklow. 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 Wicklow 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

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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 Wicklow County Council. The Wicklow 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 Wicklow County Council Development Plan 2021-2027 and the Regional Spatial and Economic Strategy for the Eastern and Midland Region were employed to assess future development patterns. In addition, 2 stakeholder workshops were held to garner further insights from Wicklow County Council.

Report Section	Sources	
Introduction and scope	• Local Authority Climate Action Plan Guidelines, Technical Annex	
Step 1: Current Climate Risks and Impacts	• Climate Status Report 2020 (Cámaro García and Dwyer, 2021) • Data.gov.ie • Dominican Wicklow • East Coast FM • Environmental Protection Agency (EPA) • Floodinfo.ie (Office of Public Works) • Greystones Guide • Irish Examiner • Joe.ie • Newstalk • Met Éireann • Oireachtas.ie • RTE News • Sectoral Climate Change Adaptation Strategies (2018) • Stakeholder Workshop • The Independent • The Irish Mirror	▪ The Irish Times ▪ The Journal ▪ The Sun ▪ Wicklow County Council Website ▪ Wicklow County Council Adaptation Strategy 2019-2024 ▪ Wicklow County Council Internal documents ▪ Wicklow News ▪ Wicklow People
Step 2: Future Climate Risks and Impacts	• High-resolution Climate Projections for Ireland – A Multi-model Ensemble Approach (Nolan and Flanagan, 2020) accessed via Climate Ireland • National Planning Framework population projections	• Regional Spatial & Economic Strategy for the Eastern and Midland Region Assembly • Transport Infrastructure Ireland

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3.2 Current Climate Risks and Impact Assessment

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3.2.1 Profile of Climate Hazards (incl. Frequency)

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Characteristics of County Wicklow

Wicklow County is located in the east of Ireland in the province of Leinster and is bordered to the east by the Irish Sea. According to the Census 2022, Wicklow County Council serves 155,485 people. The county is known for its coastal amenities, rich natural and built heritage, a wide range of recreational amenities and tourist attractions, as well as its mix of both rural and urban-based industries.

Physical & Environmental Characteristics

County Wicklow is approximately 2,027km² making it the 17th largest county in Ireland. The county is bordered by counties Dublin, Kildare, Carlow and Wexford, and flanked to the east by over 60km of the Irish Sea coastline.

The county consists of a varied mix of mountains and foothills, beaches, forests and lakes. The Wicklow Mountains is home to the largest national park in Ireland which extends over 3000 km² with the highest peak being Lugnaquilla at 926m. Other landscape features include the Sally Gap, Powerscourt Waterfall, the Bray to Greystones Cliff Walk and the monastic site of Glendalough. There are 65 geological heritage sites in the County. The Blessington Lakes/Poulaphouca reservoir is the largest manmade lake in Ireland with a surface area of 5000 acres.

The Wicklow Mountains are the largest upland area in the Republic of Ireland and are composed primarily of granite but are surrounded by mica schist and quartzite. The areas to the east and west of the Wicklow Mountains are characterised by foothills and valleys with limited areas of flat terrain. The Wicklow coastline stretches over 60kms and varies between the sea cliffs in the North of the County to the long straight shingle beaches in the south of the County.

Socioeconomic Characteristics

As of the 2022 Census, County Wicklow has a population of 155,485 people, which represents an increase of 13,060 (9.2%) since the 2016 Census. The county has experienced relatively steady population growth over recent years and has an almost exactly equal gender breakdown (72,269 Male; 70,156 Female) (2016).

Wicklow is predominantly an urban county, with 76.4% living in urban areas and 24.6% living in rural areas. Wicklow County Council has 5 municipal districts: the municipal districts of Arklow, Baltinglass, Bray, Greystones and Wicklow.

In terms of infrastructure, the main national roads from/to Wicklow are the M11/N11 - Dublin to Wicklow, and the M11 - Wexford to Wicklow. The county is accessible to and from Dublin by rail, and Greystones and Bray are serviced by the DART network. The Rosslare Europort provides access to the UK and mainland Europe with over 30 sailings per week. The nearest airport to Wicklow for commercial flights is Dublin Airport which is located over 70km away.

The county's tourism sector is an important component and driver of the economy. In 2017, 275,000 overseas tourists visited the county, generating over €73 million for the local economy. A further 319,000 domestic visitors generated an estimated €49 million. Glendalough is situated within the Wicklow Mountains National Park and attracts over one million visitors per year.

According to the Dáil Éireann Constituency Profile (2020), the county's main industries of employment include Commerce and Trade (26.3%), Professional Services (23.4%), Other (18.2%), Manufacturing and Industries (9.7%), Transport and Communications (8.5%), and Building and Construction (5.9%).

The location of Wicklow on the east coast of Ireland and its close proximity to Dublin is key for the socio-economic development of the county. A large portion of Wicklow residents (21,050) commute out of the county for employment, 88% of which are travelling to the Dublin region.

The county's Household Median Gross Income in 2016 was €48,392 and in 2021 there were 1,788 Housing Assistance Properties in County Wicklow.

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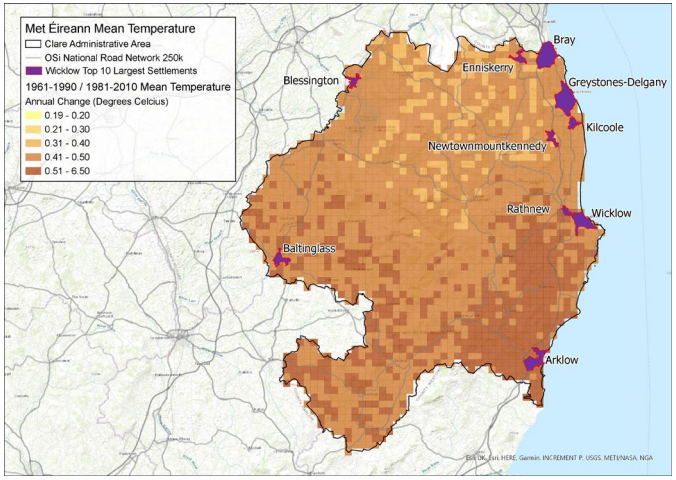
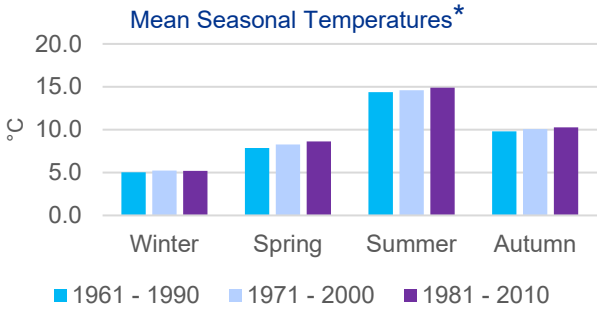
Observed Changes in Wicklow's Climate





*Source: EPA,2020
**Source: Met Éireann Long term weather station : Casement
***Source: Met Éireann weather stations : Roundwood (Filter Beds), M.Sally Gap

To assess changes in climatic conditions across County Wicklow, we have employed data from Met Éireann's network of meteorological and climatological stations. To establish a long-term climatology, a 30-year period of data is required. Due to no designated long-term weather stations being located in Wicklow county council, the Casement weather station based in Dublin was used due to its close proximity.

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

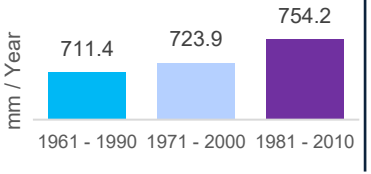
Summary of Observed Climate Change for County Wicklow

Sea Level Rise

Sea Levels around Ireland are rising at an approximate rate of 2-3mm per year*

Rainfall

Average annual rainfall at Casement has increased by 6% for the most recent period (1981-2010) compared to the 1961-1990 baseline.**



0.4°C

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

28.9°C

Highest temperature on record recorded on July 19th 2006 at Ashford (Cronykeery)

4 of the top 10 driest Summers on record since 1943 have occurred since the year 2000***

In July 2022 a large 100 hectare forest fire occurred in an area of Crone Wood, Glencree Valley which required Fire services and Air Corps to be brought under control

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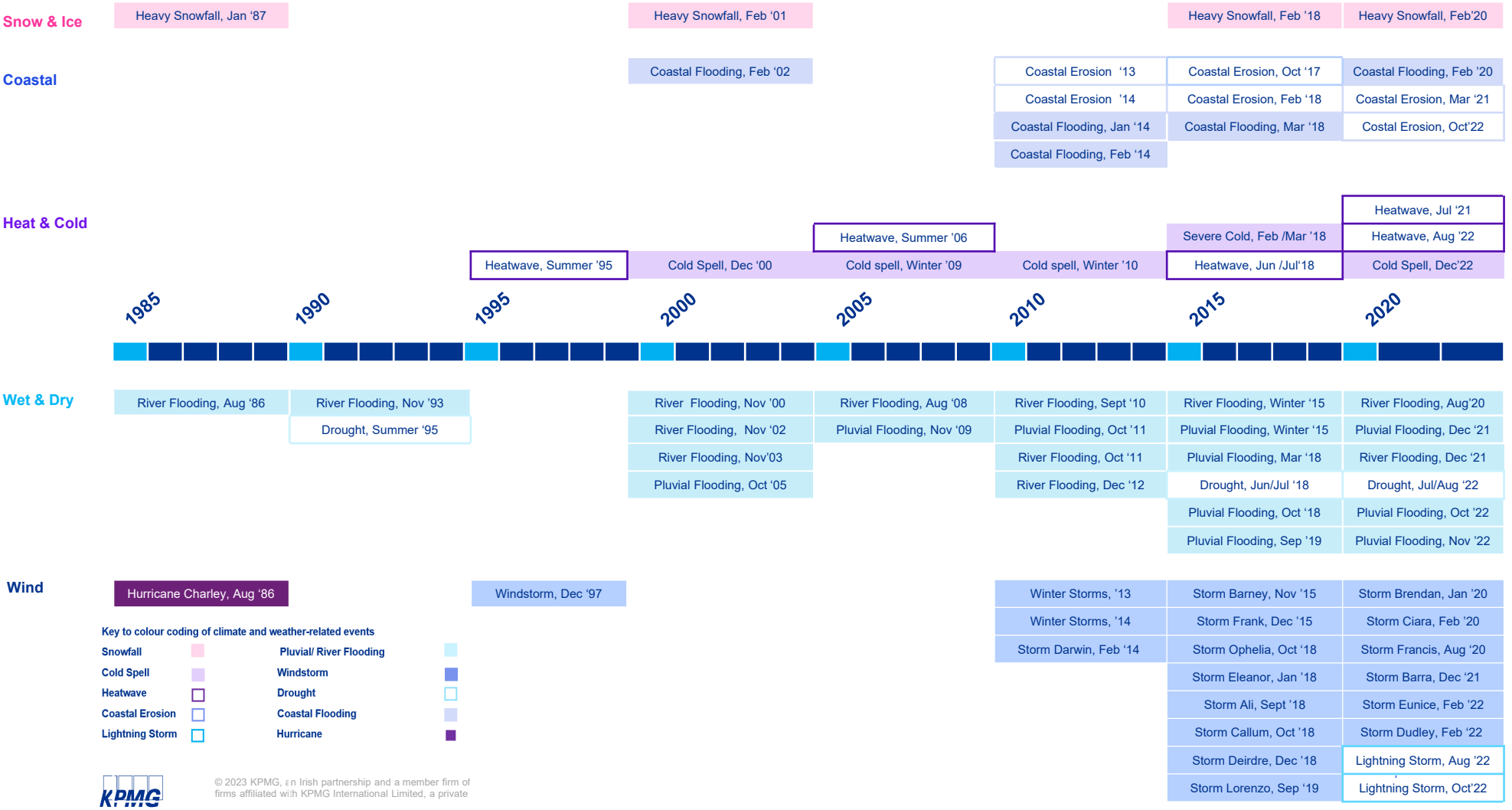
Climate Hazard Timeline

In addition to observed changes in Wicklow's climate, we have identified significant climate and weather-related events to have impacted on the county over the period 1986 -2022. To do this, we have further developed the existing climate hazard profile developed through the existing Wicklow County Council Adaptation Strategy (2019) and expanded the analysis to cover the period 2018-2022.



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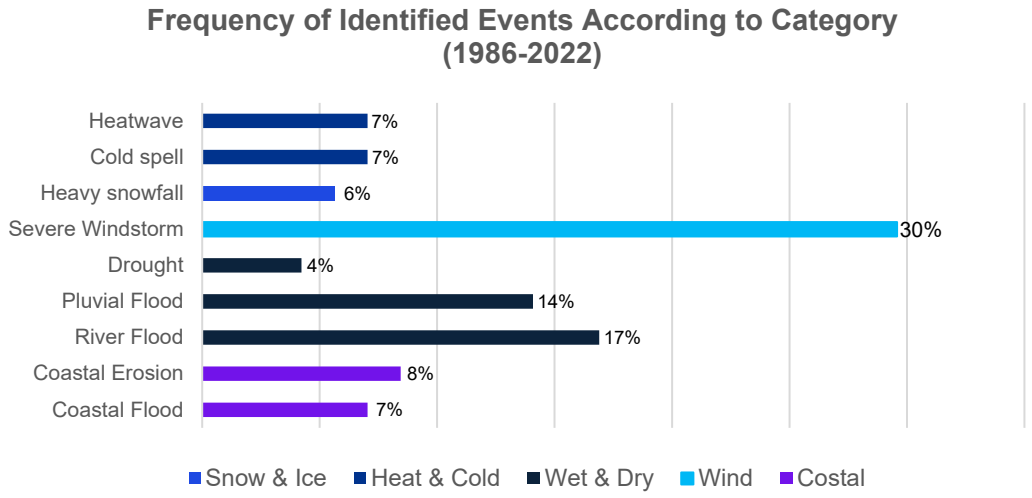
Frequency of Climate Hazards

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 Wicklow most frequently over the period 1986-2022, with significant coastal erosion and flooding, cold spell, heavy snowfall and flooding (river and pluvial) events also affecting the County on a number of occasions. Heatwave, drought and groundwater flooding have also impacted Wicklow County, 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 Wicklow 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

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

Hazard Type	Current Frequency
Heatwave	Common
Drought	Occasional
Cold spell	Frequent*
Heavy snowfall	Frequent*
Severe windstorm	Very Frequent
Pluvial Flood	Frequent
River Flood	Frequent
Coastal Flood	Frequent
Coastal Erosion	Frequent
Groundwater Flood	Occasional**

* Cold spells and heavy snowfall are experienced on a frequent basis in the Wicklow uplands with significant countywide events occurring less frequently.

** Groundwater flooding was identified through consultation workshops with Wicklow County Council as occurring on an occasional and geographically limited basis.

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3.2.2 Exposure, Vulnerability and Impacts for County Wicklow

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Exposure, Vulnerability and Impacts for County Wicklow

Key to colour coding of impact ratings

- Catastrophic
- Major
- Moderate
- Minor
- Negligible

On the basis of identified exposures, vulnerabilities and impacts for County Wicklow, the impact of climate and weather-related hazards on key categories of exposure for County Wicklow 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 Wicklow 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	Negligible	Minor	Minor	2.0
Drought	Occasional	Negligible	Negligible	Minor	Minor	Minor	Negligible	Negligible	1.4
Cold Spell	Frequent	Moderate	Moderate	Negligible	Moderate	Minor	Moderate	Minor	2.3
Heavy Snowfall	Frequent	Minor	Moderate	Minor	Moderate	Negligible	Minor	Minor	2.1
Severe Windstorm	Very Frequent	Moderate	Minor	Minor	Minor	Minor	Moderate	Moderate	2.3
Coastal Flood	Frequent	Moderate	Minor	Minor	Minor	Minor	Minor	Minor	2.1
Coastal Erosion	Frequent	Major	Negligible	Moderate	Moderate	Moderate	Major	Major	3.1
Pluvial Flood	Frequent	Minor	Minor	Minor	Minor	Negligible	Moderate	Moderate	2.1
River Flood	Frequent	Major	Minor	Minor	Moderate	Negligible	Moderate	Moderate	2.6
Groundwater Flood	Occasional	Minor	None	Negligible	Negligible	None	Negligible	None	0.7

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Impacts of Current Climate Risks – Heatwaves & Drought

County Wicklow has been exposed to heatwave events (defined as 5 consecutive days with temperatures >25 deg. C) over the period 1986-2022 with a wide range of impacts across the county. The most notable and costly impact relate to the repair and maintenance of road surfaces and responding to uncontrolled fires. In addition, County Wicklow has experienced drought conditions over the period as exemplified by drought events in July 2018 and 2022.

Key to colour coding of impact ratings

- Catastrophic
- Major
- Moderate
- Minor
- Negligible

Hazard & Frequency	Exposure	Impact Description	Rating
Heatwave Common	**Assets**	• High temperatures have resulted in localised damage to road surfaces (tar and chip) across the County, such as during the August 2022 heatwave. • In 2018, gorse fire was reported at Rocky Valley Cresent , Kilmacanogue, County Wicklow, which the fires services spent most of the day battling to prevent the fire spreading to nearby houses and a school.	Moderate
	Health and Well being	• High indoor temperatures have resulted in uncomfortable working conditions for staff and public with the potential for impacts on heat sensitive equipment (e.g., Council laboratories). This has resulted in the increased requirement for active/mechanical cooling.	Negligible
	Environment	• Heatwaves provide suitable conditions for the ignition of uncontrolled fires. In July 2022, a 100 hectare forest fire in Crone Wood, Glencree Valley required assistance form the Fire services and Air Corps to be brought under control. In 2018, 7 significant fires were reported, some of which (including those at Liffey Head and Lough Bray) lasted for weeks. • Heatwaves provide suitable conditions for the development of algal blooms in waterbodies, notably at Blessington lakes in 2018.	Moderate
	Social	• Heatwaves have resulted in congestion at key recreational areas with facilities (e.g., litter collection and parking) overwhelmed. The 2019 heatwave led to high visitor numbers and associated traffic and litter control challenges at sites such as Blessington Lakes, Glendalough, and Brittas Bay. • High temperatures in 2021 led to road blockages at Brittas Bay and Maghermore, hindering access by emergency services.	Minor
	Cultural Heritage	• Extreme temperatures are recognised as contributing to the increased weathering of cultural heritage sites.	Negligible
	Financial	• The financial implications of heatwaves are primarily associated with emergency response (e.g. fire), road maintenance and repair.	Minor
	Reputational	• Heatwaves have had a negligible reputational impact for Wicklow County Council.	Minor
Drought Occasional	**Assets**	• Drought conditions (e.g. Summer 2018) resulted in the imposition of restrictions on water supply (e.g. hosepipe bans and night time restrictions) on a national and county basis.	Negligible
	Health and Well being	• 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	• High temperatures and dry conditions, often compounded by high levels of ignition activity, have resulted in uncontrolled fires as evidenced in 2017 and 2021.	Minor
	Social	• Water restrictions can lead to inconvenience for local businesses and residents.	Minor
	Cultural Heritage	• Drought conditions results in damage to cultural heritage sites due to weathering and drying out of substrate.	Minor
	Financial	• The financial implications of drought are limited and restricted to responding to wildfire and supporting the provision of water (e.g., tankering).	Negligible
	Reputational	• The reputational impacts of drought conditions are limited and localised.	Negligible

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Impacts of Current Climate Risks – Cold Spells & Heavy Snowfall

Upland areas of County Wicklow experience cold spells and heavy snowfall events on a frequent basis with significant county wide events (e.g. 2009,2010 2018, 2020) experienced less frequently. These events have wide ranging impacts across the County including disruption of transport routes, damage to buildings, and isolation of communities.

Key to colour coding of impact ratings

- Catastrophic
- Major
- Moderate
- Minor
- Negligible

Hazard & Frequency	Exposure	Impact Description	Rating
Cold Spell **Frequent**	**Assets**	• Cold spells have resulted in road closures, transport disruption and increased maintenance and repair costs across the county. Freeze thaw action has resulted in damage to critical infrastructure (E.g., water infrastructure) and building stock. Cold weather in 2018 led to the failure of chlorine pumps and the issuing of boil water notices for Aughrim, Annacurra and Barndarrig. • Extreme cold conditions in combination with snowfall have resulted in the widespread closure of business (incl. LA business services).	Moderate
	Health and Well being	• 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. • During Storm Emma, nine sheep got buried alive in snow in County Wicklow and were rescued by the owner after digging for four hours.	Moderate
	Environment	• Cold spells have led to decreased water availability and have detrimental impacts for biodiversity and habitats, resulting in a decrease of ecosystem health.	Negligible
	Social	• Road closures have resulted in social isolation for remote communities. In December 2022, the Sally Gap was declared impassable to traffic. • Elderly and vulnerable populations are required to stay in place during freezing events resulting in isolation.	Moderate
	Cultural Heritage	• Freeze thaw has been identified as having detrimental impacted on the structural integrity of cultural heritage sites.	Minor
	Financial	• 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. The total estimated cost for freeze thaw damage to the road network during Storm Emma was approx. €5.94 million.	Moderate
	Reputational	• Isolation of communities and council response (e.g., gritting) across the county receives media attention but with limited reputational impact for County Wicklow.	Minor
Heavy Snowfall **Frequent**	**Assets**	• Heavy snowfall has resulted in road closures and transport disruption. Snowfall associated with Storm Emma in March 2018 led to the closure of the Sally Gap and the N81 becoming impassable, with Wicklow fire services being required to rescue stranded motorists. • 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). • Accumulation of snowfall can cause power lines to sag and suffer damage, or to freeze and cause disruption. Storm Emma in March 2018 led to power faults in Arklow and Enniscorthy, and to energy disruption for more than 800 homes in Wicklow Town, Rathnew and Ashford.	Minor
	Health and Well being	• Extreme cold events have resulted in treacherous conditions and increased incidence of slips and falls amongst public and staff. During Storm Emma in 2018, a family in Kennystown, Carnew, County Wicklow got trapped in their home for four days until rescued.	Moderate
	Environment	• Flooding post-heavy snowfall event results in overland flow of pollutants to habitats and ecosystems with detrimental effects.	Minor
	Social	• Road closures can result in significant social isolation for communities. During Storm Emma in March 2018, the Defence Forces and civil authorities, along with contractors, were required to clear snow and ice from footpaths in Blessington and Roundwood, freeing access for residents.	Moderate
	Cultural Heritage	• Accumulations of heavy snowfall can result in damage to cultural heritage sites.	Negligible
	Financial	• The financial implications of cold spells are primarily associated with maintenance and repair costs for local and regional roads, buildings and assets.	Minor
	Reputational	• Isolation of communities and council response (e.g., gritting) across the county receives media attention but with limited reputational impact for the county.	Minor

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Impacts of Current Climate Risks - Windstorms

County Wicklow has been frequently exposed to wind storms over the period 1986-2022, notable examples being Storms Eleanor, Barra and Ophelia. Impacts have been experienced across the county and 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**	• Windstorms has caused direct damage to building stock and other assets. Winter storms in 2015 caused damage to the roofs of council housing requiring repairs at a cost of €38k. In October 2019, Storm Lorenzo led to two boats moored in Wicklow Town becoming badly damaged. • Windstorm damage to power and communication transmission infrastructure (e.g., tree fall on overhead lines) has resulted in disruption of communications and energy supply. High winds in January 2023 led to more than 2,000 homes in the county going without power. Storm Dudley in February 2022 led to power outages around Kilcoole. • Windstorms can disrupt wind energy generation. A lighting strike in October 2022 caused a wind turbine off the coast of Arklow to catch fire, prompting a debris warning to be issued by Wicklow County Council. Storm Francis in August 2020 led to power outages in Arklow, Rathdrum, Greystones, Kilcoole and Baltinglass. • Windstorms have caused disruption of transport routes as a result of treefall.	Moderate
	Health and Well being	• Windstorms posed a health and safety risk for the public with potential for injury. During Storm Barra in 2021,there were two incidents of cars being hit by falling trees in Newcastle and Coynes Cross.	Minor
	Environment	• Windstorms have resulted in loss of trees and this is particularly the case for vulnerable tree species. During Storm Eunice in 2022, there were also reports of trees down in Newtownmountkennedy and the Greenhill Road in Wicklow town. One tree partially collapsed at Nun's Cross in Ashford and had to be removed.	Minor
	Social	• 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.	Minor
	Cultural Heritage	• Severe wind storms has caused structural damage to cultural heritage sites.	Minor
	Financial	• The financial impacts of severe wind storm are associated with clean-up and repair cost. Following Storm Ophelia, national government paid over €50,526 to Wicklow County Council to cover the costs of repairing the damage.	Moderate
	Reputational	• Reputational damage as a result of wind storms is limited and associated with short term media reporting on council preparedness and response.	Moderate

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Impacts of Current Climate Risks - Coastal Flooding and Erosion

County Wicklow has 195 km of coastline, most of which is considered to be 'soft coastline', with areas such as The Murrough between Wicklow Town and Greystones considered to be at high risk of coastal erosion. In addition, County Wicklow is exposed to coastal storms with a number of areas subject to frequent and recurring flooding.

Key to colour coding of impact ratings

- Catastrophic
- Major
- Moderate
- Minor
- Negligible

Hazard & Frequency	Exposure	Impact Description	Rating
 **Coastal Erosion** **Frequent**	**Assets**	• Assets, infrastructure and communities are currently at risk from coastal erosion. Irish Rail have estimated that €230 million will be required to protect parts of the rail line between South Dublin and Wicklow, notably the Greystones to Bray Head section.	Major
	Health and Well being	• 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. In February 2021, two sections of cliff collapse occurred along the Bray to Greystones cliff walk, leading to the walk being closed for safety.	Negligible
	Environment	• Coastal erosion results in damage to coastal habitats, such as at the Murrough and at Brittas Bay. • Bray Cliff is getting eroded by surface water runoff from all the lands above the walk. Collapse of cliff on the Greystones side of the cliff walk was reported in Feb 2021.	Moderate
	Social	• Road closures as a result of coastal erosion can result in significant social isolation for communities.	Moderate
	Cultural Heritage	• Erosion of sand dune systems can take place in protected areas, such as Special Areas of Conservation. In 2018, 5 metres of the Turlough Wetlands (SAC) were washed away due to Storm Emma. The ruins of Black Castle, which can dated back to the 11th century, are at risk of coastal erosion.	Moderate
	Financial	• The financial implications of coastal erosion are primarily related to the development and maintenance of coastal defence works. In 2021, a coastal erosion plan was commissioned by Irish Rail at an estimated cost of €145 million to carry out works along the coastline from Bray to the Murrough in Wicklow town.	Major
	Reputational	• Coastal erosion issues has the potential to cause significant reputational damage to County Wicklow. This is particularly the case as critical transport networks and dwellings are considered at significant risk from coastal erosion.	Major
 **Coastal Flood** **Frequent**	**Assets**	• Coastal flooding can result in transport disruption, road closures and direct damage to building stock and other assets. In 2018, Storm Emma caused damage to rock armour protecting the Dublin to Wicklow rail line. In 2014, flooding in Bray caused the Strand Road to be closed, along with damage to a number of commercial properties. The River Dargle Flood Defence Scheme, completed in 2017, included works to prevent further hydrodynamic scour to the coastal Fran O'Toole bridge in Bray. • Coastal flooding can lead to temporary inundation of buildings. In 2019, a storm surge led to 3 houses in Wicklow Town being flooded.	Moderate
	Health and Well being	• Coastal flooding poses risks to health and well being of the public and staff working in exposed areas.	Minor
	Environment	• Coastal flooding has detrimental impacts on coastal ecosystems, causing an overall reduction in ecosystem health, such as at Brittas Bay. • Coastal flooding results in damage to amenities located in coastal habitats.	Minor
	Social	• Closure of transport routes due to coastal flooding results in significant social isolation for communities. In 2014, coastal flooding along the Bray promenade caused damage to the Queen of Peace Youth Club and Bray Rowing Club.	Minor
	Cultural Heritage	• Coastal flooding can cause structural damage to cultural heritage sites.	Minor
	Financial	• Financial implications associated with coastal flooding relate to increased costs associated with emergency response (e.g. pumping), clean-up and repair. The flooding of the Strand Road in Bray in 2014, required alleviation works.	Minor
	Reputational	• For those areas subjected to frequent inundations, there is a potential for reputational damage to the Council on a localised basis.	Minor

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Impacts of Current Climate Risks - Pluvial and Fluvial Flooding

For County Wicklow in the period 1986-2022, pluvial and fluvial flooding have occurred on a frequent basis. Areas of exposure to fluvial flooding are limited geographically but with the potential for frequent exposure for fluvial flooding. Transport services were disrupted and roads got damaged during pluvial flooding in 2022, M11 and N11 got flooded due to extensive rainfall..

Key to colour coding of impact ratings

- Catastrophic
- Major
- Moderate
- Minor
- Negligible

Hazard & Frequency	Exposure	Impact Description	Rating
 **Pluvial Flood** **Frequent**	**Assets**	• Pluvial flooding has resulted in the temporary inundation of assets. Heavy rainfall in March 2018 led to houses in Rathdrum and Kilmacanogue being flooded. Heavy rainfall in September 2019 led to similar flooding of houses in Wicklow Town. • Pluvial flooding results in damage to road surfaces and disruption of transport networks. Rainfall in November 2022 caused the M11 and N11 to be flooded north of Gorey, with a number of roads in the town being impassable. Flooding in December 2021 affected the Enniskerry Road, R747 and the M11. Flooding in March 2018 led to the road between Roundwood and Kilmacanogue becoming almost impassable.	Minor
	Health and Well being	• Heavy precipitation and floodwater leads to dangerous driving conditions for both council staff and public.	Minor
	Environment	• Pluvial flooding has resulted in the overland flow of pollutants (nutrients, sediment and pesticides) with impacts on terrestrial and freshwater ecosystems. In August 2020 a 'do not swim' notice was put in place south of Bray harbour, with one of the likely causes being storm water outfalls from Bray sewerage pumping station. • Clogga in County Wicklow was placed under temporary swimming ban due to suspected agricultural activities/runoff in July 2021. • Pluvial flooding can cause landslides and damage to local habitats.	Minor
	Social	• Road closures can result in significant social isolation for communities.	Minor
	Cultural Heritage	• Pluvial flooding puts built heritage with stone cavities at risk of soakage and leakage.	Negligible
	Financial	• The financial implications of emergency response (e.g. pumping and emergency co-ordination, clean-up and repair) can be significant. Heavy rainfall in October 2022 required the attendance of fire services to free up drains along South Beach, Greystones. Rainfall associated with the winter storms of 2015 caused extensive damage to drains and culverts, with repairs costing €1.35 million. • Increased budget pressure to adapt to impact of climate change, e.g. flood protection measures and upgrading of existing drainage systems.	Moderate
	Reputational	• Pluvial flooding issues are county wide and can result in reputational damage to the council.	Moderate
 **River Flood** **Frequent**	**Assets**	• River flooding has resulted in the inundation and damage of buildings and assets. In December 2021, a number of premises in Baltinglass were flooded when the river Slaney burst its banks. • Flood debris led to damage to the Weir in Ashford during the winter storms of 2015. • River flooding results in transport disruption and road closures. In August 2008, the Delgany to Greystones Road experienced severe flooding. In December 2012, roads in the Killincarrig and Enniskerry areas experienced flooding. During the Winter of 2015, Lodge Lane in Lacken was washed away by floods. The Glenamalure Valley was badly hit by floods in August 2020. • River flooding and fast flowing rivers can cause damage to bridges through hydrodynamic scour. In November 2011, the Ballinstockan Bridge on the Lake Drive between Lacken and Ballyknockan was completely washed away by floods.	Major
	Health and Well being	• 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.	Minor
	Environment	• River flooding can result in the overland flow of pollutants (nutrients, sediment and pesticides) with impacts on terrestrial and freshwater ecosystems.	Minor
	Social	• Road closures can result in significant social isolation for communities. In November 2000, the villages of Aughrim, Shillelagh, and Avoca were completely isolated following the Avoca River and several other rivers bursting their banks. In Winter 2015, flooding washed away Lodge Lane in Lacken, causing the isolation of nearby homes. • Inhibited development of communities as a result of frequent river flooding.	Moderate
	Cultural Heritage	• A number of the county's cultural heritage and archaeological sites are situated near river systems and are particularly exposed to river flooding. Between 2010 and 2012, there were three instances of flooding damaging the Glendalough visitor centre.	Negligible
	Financial	• 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.	Moderate
	Reputational	• River flooding issues are observed county wide and can result in reputational damage to the council.	Moderate

Impacts of Current Climate Risks – Groundwater Flooding

For the period 1986-2022, groundwater flooding has occurred occasionally, with negligible and localised impact.

Key to colour coding of impact ratings

- Catastrophic
- Major
- Moderate
- Minor
- Negligible

Groundwater Flood

Occasional

Hazard & Frequency	Exposure	Impact description	Rating
Groundwater Flood – Occasional	**Assets**	• Groundwater flooding can result in flooding of road infrastructure and transport disruption.	Minor
	Health and Wellbeing	• None	None
	Environment	• Flooding can result in the overland flow of pollutants (nutrients, sediment and pesticides) with impacts on terrestrial and freshwater ecosystems, such as a Ennereilly.	Negligible
	Social	• Road closures can result in potential social isolation for communities.	Negligible
	Cultural Heritage	• None	None
	Financial	• There is a potential of financial impacts of groundwater flooding associated with clean-up and repair cost.	Negligible
	Reputational	• None	None

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3.2.3 Impact Assessment (Service Delivery)

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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 Wicklow will have direct and indirect consequences for the delivery of services by Wicklow County Council before, during and after the event.

On the basis of reported information and in consultation with Wicklow County Council, an assessment of the impacts of identified climate change hazards and impacts on the delivery of services by Wicklow 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 Wicklow 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	Business Services	Roads, footpaths, bridges: construction and maintenance	Building Stock	Community Infrastructure	Cultural Heritage	Stormwater / Sewerage	Wastewater*	Water Supply*	Water Quality	Biodiversity	Community Development	Emergency Response
Heatwave	Minor	Moderate	Minor	Moderate	Minor	None	None	Moderate	Negligible	Moderate	Minor	Moderate
Drought	None	None	None	None	Minor	None	None	Minor	Minor	Minor	Minor	Minor
Cold spell	Minor	Moderate	Minor	Minor	Minor	Moderate	Moderate	Moderate	Minor	Moderate	Moderate	Moderate
Heavy Snowfall	Minor	Moderate	Minor	Moderate	Minor	None	None	Minor	Minor	Minor	Moderate	Moderate
Severe windstorm	Moderate	Moderate	Moderate	Moderate	Minor	None	Moderate	Moderate	Negligible	Minor	Moderate	Moderate
Pluvial Flood	Moderate	Moderate	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
River Flood	Moderate	Moderate	Minor	Minor	Minor	Minor	None	Minor	Minor	Minor	Minor	Moderate
Coastal Flood	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	None	Minor	Minor	Minor
Coastal Erosion	Minor	Moderate	None	Moderate	Minor	None	None	None	None	Moderate	Minor	Minor
Groundwater Flood	None	Minor	None	None	None	None	None	None	None	Negligible	Negligible	None

*Delivered through an SLA with Irish Water

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Service Level Impacts (Heatwaves & Droughts)

Heatwaves and drought result in a range of impacts for service provision by Wicklow 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
Business Services	• Increased staff and customer discomfort as a result of high indoor temperatures with potential for decreased productivity.	• None
Roads, footpaths, bridges, construction and maintenance	• Increased costs associated with repair of road surfaces across the county. • Increased health and safety risk for outdoor staff members across the county.	• None
Building Stock	• Increased requirement for cooling in council offices/buildings.	• None
Community Infrastructure	• Increased requirement for waste collection and traffic management at key recreational sites.	• None
Cultural Heritage	• Increased requirements for monitoring, maintenance and repair of cultural heritage sites.	• Increased requirements for monitoring and maintenance of cultural heritage sites.
Stormwater / Sewerage	• None	• None
Wastewater	• None	• None
Water Supply	• Increased demand for water to cool infrastructure, communities, and livestock. • Implementation of water conservation measures (e.g., hosepipe bans).	• Implementation of water conservation measures (e.g., hosepipe bans). • Increased requirement to support provision of water to communities suffering loss of water supply (e.g., Tankering).
Water Quality	• Reduced water flows impacting on water quality in local areas with increased requirement for monitoring and remediation.	• Reduced water flows impacting on water quality in local areas with increased requirement for monitoring and remediation.
Biodiversity	• Increased requirement for monitoring and remediation of priority sites and potential inability to meet conservation objectives.	• Reduced water flows impacting on biodiversity with potential for loss of priority species and habitats necessitating increased monitoring and remediation.
Community Development	• Increased requirement for management at congested sites.	• Reduced grass growth causing increased supplementary feed requirement for cattle reducing farm incomes and the wider industry.
Emergency Response	• Increase in number of wildfire call-outs across the county. • Increase in number of call out to bathing areas throughout the county.	• Increase in number of uncontrolled fire call-outs at a localised level..

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Service Level Impacts (Cold and Heavy Snowfall)

Cold spells and heavy snowfall have significant impacts across County Wicklow with direct and indirect consequences for the delivery of services by Wicklow County Council. Impacts are related primarily to maintenance and repair 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
Business Services	• Localised disruption and closure of local authority services.	• Localised disruption and closure of local authority services.
Roads, footpaths, bridges: construction and maintenance	• Increased costs associated with gritting and salting roads across the county. • Increased repair and maintenance costs.	• Transport disruption and road closures. • Increased costs associated with gritting and salting roads and footpaths around the county.
Building Stock	• Increased energy costs for buildings. • Increased health and safety risks for public and staff.	• Increased energy costs for buildings in local areas. • Increased health and safety risks for public and staff in local areas.
Community Infrastructure	• Closure of community infrastructure and services. • Increased repair and maintenance costs.	• Increased health and safety risks for public and staff. • Closure of services throughout communities in the county.
Cultural Heritage	• Increased energy costs for cultural heritage sites. • Increased health and safety risks for public and staff at heritage sites.	• Increased health and safety risks for public and staff. • Widespread closure of sites.
Stormwater/Sewerage	• Following cold spell events, runoff from snow melt exceeds capacity of stormwater drainage resulting in standing water. • Damage to stormwater infrastructure with increased requirement for maintenance and repair across the county.	• None
Wastewater	• Damage to wastewater infrastructure across the county with increased requirement for maintenance and repair (Additional demand on LA Staff working under the SLA with Irish Water).	• None
Water Supply	• Increased maintenance and repair costs of water service infrastructure across the county (Additional demand on LA Staff working under the SLA with Irish Water). • Increased requirement to supply water to communities affected by water supply disruption (Additional demand on LA Staff working under the SLA with Irish Water).	• Increased maintenance and repair costs of water service infrastructure across the county (Additional demand on LA Staff working under the SLA with Irish Water). • Increased requirement to supply water to communities affected by water supply disruption (Additional demand on LA Staff working under the SLA with Irish Water).
Water Quality	• Deterioration of water quality at environmental sensitive sites resulting in increased requirement for monitoring.	• Deterioration of water quality at environmental sensitive sites resulting in increased requirement for monitoring.
Biodiversity	• Prolonged cold spells impacting biodiversity and ecosystems, resulting in increased monitoring and remediation.	• Heavy Snowfall impacting biodiversity and ecosystems, resulting in increased monitoring and remediation.
Community Development	• Increased instances of community isolation. • Significant impact on the county's economy.	• Increased instances of community isolation. • Significant impact on the county's economy.
Emergency Response	• Increase in number of call-outs.	• Increase in number of call-outs. • Increase in response times due to heavy snowfall on roads around the county.

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Service Level Impacts (Windstorms)

Severe windstorms can result in the closure and/or disruption of Wicklow County Council Offices and services. Primary impacts of severe windstorms are associated with disruption of services and infrastructures 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
Business Services	• Widespread closure of business services. • Increased health and safety risks for public and staff.
Roads, footpaths, bridges: construction and maintenance	• Countywide transport disruption and road closures affecting the wider community and local authority operations. • Increased clean-up and repair costs after an event.
Building Stock	• Closure of buildings and disruption of services as a result of direct damage to buildings and disruption of power. • Increased clean-up and repair cost of damages.
Community Infrastructure	• Disruption to delivery of community services across the county. • Increased clean-up and repair costs after an event.
Cultural Heritage	• Increased maintenance and repair costs due to storm damage to cultural heritage sites.
Stormwater/Sewerage	• None
Wastewater	• Increased maintenance and repair costs for wastewater infrastructure across the county (Additional demand on LA Staff working under the SLA with Irish Water).
Water Supply	• Countywide water supply issues due to damaged water supply infrastructure (Additional demand on LA Staff working under the SLA with Irish Water).
Water Quality	• Adverse weather conditions causing disruptions to water quality monitoring. • Additional demand on LA Staff working under the SLA with Irish water.
Biodiversity	• High winds result in damage to habitats.
Community Development	• Disruption of power and communications infrastructure, damage to buildings and infrastructure, and closure of business result in adverse impacts for the local economy.
Emergency Response	• Increase in number of calls to emergency services. • Increase in response times due to severe windstorms around the county.

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Service Level Impacts (Pluvial & River Flood)

Pluvial and river flooding have resulted in a wide range of impacts for Wicklow 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
Business Services	• County wide disruption and closure of local authority services.	• County wide disruption and closure of local authority services.
Roads, footpaths, bridges: construction and maintenance	• County wide transport disruption and road closures. • Increased clean-up and repair costs after an event.	• County wide transport disruption and road closures. • Increased clean-up and repair costs after an event.
Building Stock	• Increased maintenance and repair costs. • Increased requirement for flood defence measures.	• Increased maintenance and repair costs. • Increased requirement for flood defence measures.
Community Infrastructure	• Closure of community infrastructure and services at a localised level. • Increased repair and maintenance costs.	• Localised closure of community infrastructure and services. • Increased repair and maintenance costs.
Cultural Heritage	• Closure of cultural heritage sites at a localised level. • Increased maintenance and repair costs.	• Closure of cultural heritage sites at a localised level. • Increased maintenance and repair costs.
Stormwater/Sewerage	• Reduced capacity for drainage resulting in standing water. • Damage to stormwater infrastructure at a localised level. • Increased maintenance and repair costs.	• Reduced capacity for drainage resulting in standing water. • Damage to stormwater infrastructure at a localised level . • Increased maintenance and repair costs.
Wastewater	• Damage to local wastewater treatment plants (Additional demand on LA Staff working under the SLA with Irish Water).	• None
Water Supply	• Water supply issues at a localised level requiring supplemental water provision (Additional demand on LA Staff working under the SLA with Irish Water).	• Water supply issues at a localised level requiring supplemental water provision (Additional demand on LA Staff working under the SLA with Irish Water).
Water Quality	• Deterioration of water quality due to overland flow of pollutants resulting in water supply issues and an increased requirement for monitoring and remediation.	• Deterioration of water quality due to overland flow of pollutants resulting in water supply issues and an increased requirement for monitoring and remediation.
Biodiversity	• Detrimental impacts on environmentally sensitive areas requiring monitoring and/or restoration work.	• Detrimental impacts on environmentally sensitive areas requiring monitoring and/or restoration work.
Community Development	• Inhibited development of communities.	• Inhibited development of communities.
Emergency Response	• Increase in pressure on emergency services.	• Increase in pressure on emergency services.

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Service Level Impacts (Coastal Flood & Erosion)

Coastal flood and erosion result in a range of impacts for service provision by Wicklow County Council. Impacts of Coastal flood are associated with clean-up and repair costs, damage to assets and infrastructure and damage to environmentally sensitive areas. The primary impacts of Coastal erosion are associated with damages to assets and infrastructure and damages to coastal habitats.

Key to colour coding of impact ratings

- Catastrophic
- Major
- Moderate
- Minor
- Negligible

	Coastal Flood	Coastal Erosion
Business Services	• Closure of local business services. • Health and safety risks for public and staff.	• Health and safety risks for public and staff
Roads, footpaths, bridges: construction and maintenance	• Transport disruption and road closures across local areas. • Increased clean-up and repair costs.	• Closure and increased costs of maintenance and repair of infrastructure located in areas at risk of coastal erosion. • Increased health and safety risk for outdoor staff members.
Building Stock	• Inundation of building stock. • Increase in maintenance and repair costs.	• None
Community Infrastructure	• Damage to community infrastructure such as parks and refuse collection points. • Closure of community infrastructure and services. • Increased repair and maintenance costs.	• Damage to community infrastructure such as parks and refuse collection points. • Increased repair and maintenance costs.
Cultural Heritage	• Damage to heritage sites exposed to costal flooding. • Increased Health and safety risks for public and staff. • Increased maintenance and repair costs.	• Damage to heritage sites exposed to coastal erosion. • Increased health and safety risks for public and staff. • Increased maintenance and repair costs.
Stormwater/Sewerage	• Damage to stormwater infrastructure at a localised level. • Increased maintenance and repair costs.	• None
Wastewater	• Damage to wastewater infrastructure with increased requirement for maintenance and repair at a localised level (Additional demand on LA Staff working under the SLA with Irish Water).	• None
Water Supply	• Damage to critical water supply infrastructure with increased requirement for maintenance and repair (Additional demand on LA Staff working under the SLA with Irish Water).	• None
Water Quality	• None	• None
Biodiversity	• Damage to coastal habitats resulting in a decrease of ecosystem health at a localised level and an increased requirement for monitoring and remediation.	• Damage to coastal habitats resulting in a decrease of ecosystem health across the county and an increased requirement for monitoring and remediation.
Community Development	• Inhibited development of local communities. • Damages to buildings and travel disruptions impacting local economies.	• Inhibited development of communities as a result of coastal erosion at a localised level. • Closure and damage of recreational facilities.
Emergency Response	• Increased pressure on emergency response.	• Increased pressure on emergency response.

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Service Level Impacts (Groundwater Flooding)

Groundwater flooding has limited impacts for service delivery by Wicklow County Council. The impacts are primarily associated with repair of road surfaces.

Key to colour coding of impact ratings

- Catastrophic
- Major
- Moderate
- Minor
- Negligible

	Groundwater Flood
Business Services	• None
Roads, footpaths, bridges: construction and maintenance	• Degradation of roads with limited drainage capacity increases due to extended periods of time submerged. • Increased clean up and repair costs.
Building Stock	• None
Community Infrastructure	• None
Cultural Heritage	• None
Stormwater/Sewerage	• None
Wastewater	• None
Water Supply	• None
Water Quality	• None
Biodiversity	• Isolated and limited damage to environmentally sensitive areas requiring monitoring and/or restoration work.
Community Development	• Inhibited development of communities at a localised level.
Emergency Response	• None

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3.2.4 Current Climate Risk Matrix

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Current Climate Risk Matrix

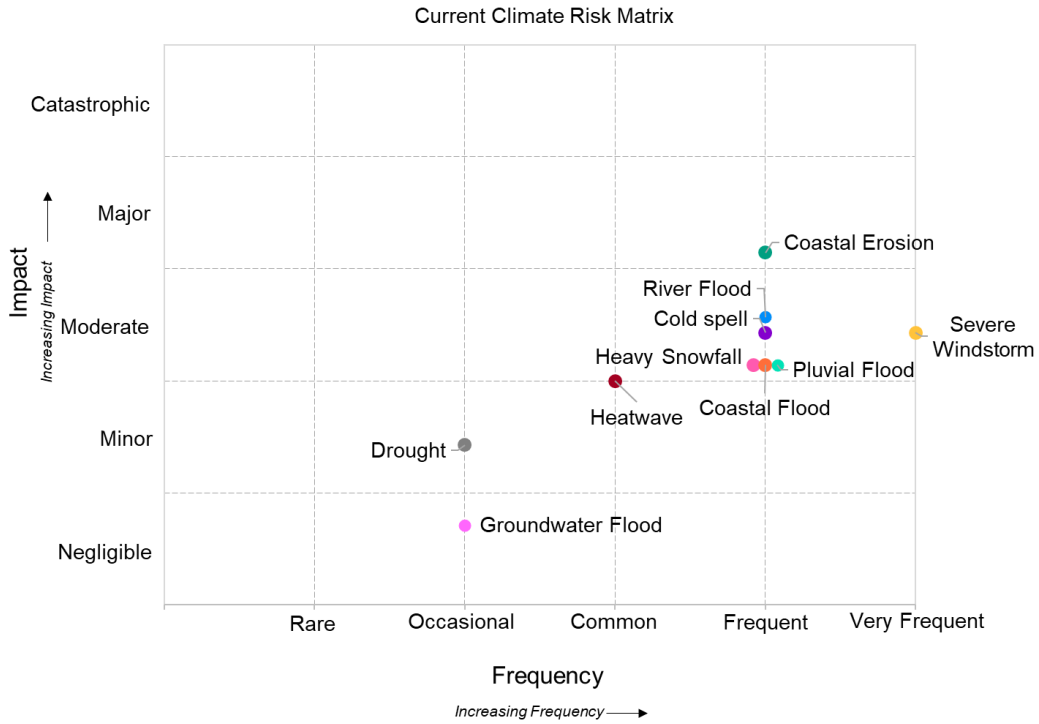
Based on reported information and in consultation with Wicklow County Council, a current climate risk matrix for County Wicklow has been developed based on the frequency of hazard occurrence and the associated level of impact.

The assessment identified **severe windstorm** as posing the highest level of risk for County Wicklow in the current period**.** The impacts of windstorms are primarily associated with disruption and damage to power and communications infrastructure. **Coastal erosion** along the Wicklow coastline is ongoing, and has significant impacts on coastal assets and infrastructure (e.g. the eastern rail corridor) and sites of environmental significance (e.g. the Murrough).

Cold spells and heavy snowfall occur on a frequent basis across the Wicklow uplands resulting in transport disruption through key mountain passes and isolation of upland communities. Significant cold spell and heavy snowfall events across the County are less frequent but with significant impacts.

River, pluvial and coastal flooding have been identified as posing a relatively high risk for County Wicklow and occur on frequent basis with a moderate impact primarily associated with localised damage to assets and infrastructure and potential for isolation of communities and vulnerable populations. **Heatwaves** occur on a common basis across County Wicklow; however, the overall impact of heatwaves is considered minor with impacts primarily associated with an increase in the frequency of uncontrolled fire, damage to road surfaces and increased pressure on recreational sites.

Droughts and **groundwater flooding** are considered to occur on an occasional basis. The impacts of droughts are primarily associated with an increase in the frequency of uncontrolled fire and associated environmental degradation. Groundwater flooding impacts are associated with disruption of road transport at a localised scale.



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

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3.3 Future Climate Risks and Impact Assessment

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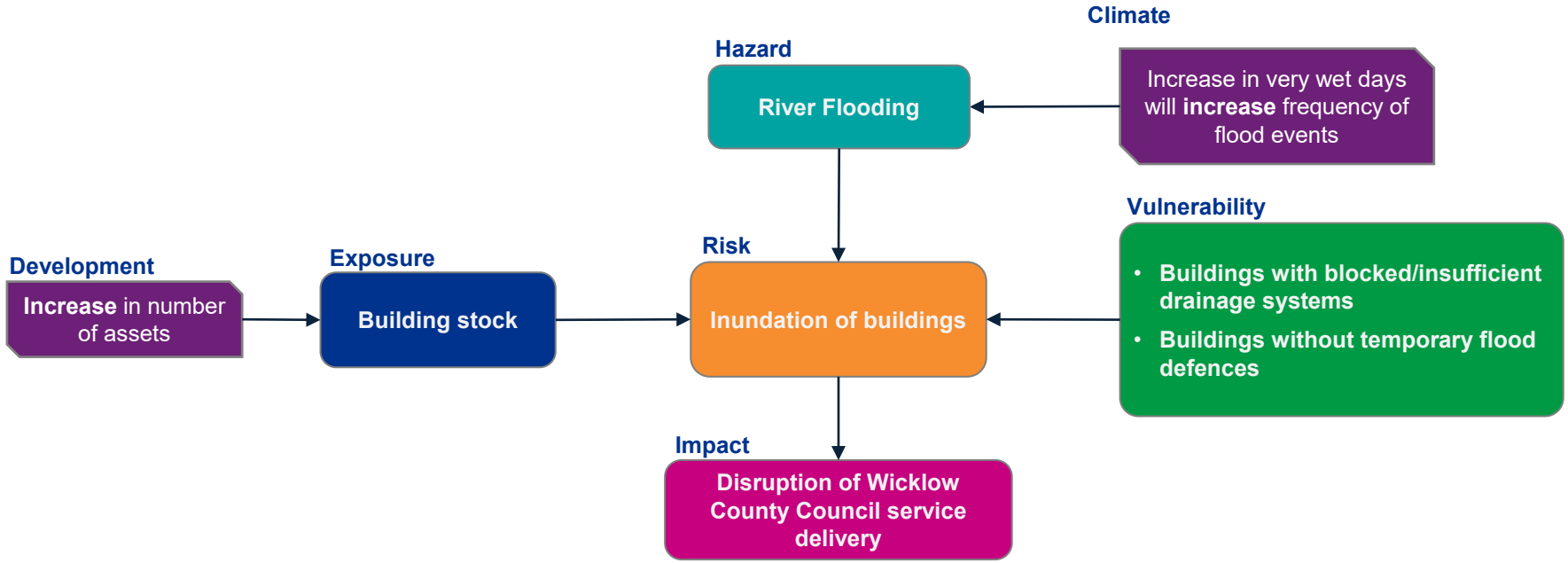
Future Climate Risk and Impact

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 Wicklow 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 Wicklow 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.



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3.3.1 Future Changes in Climate Hazards

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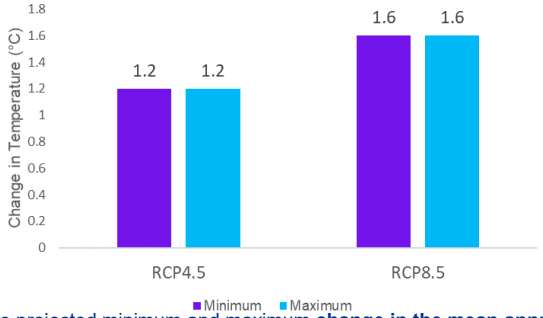
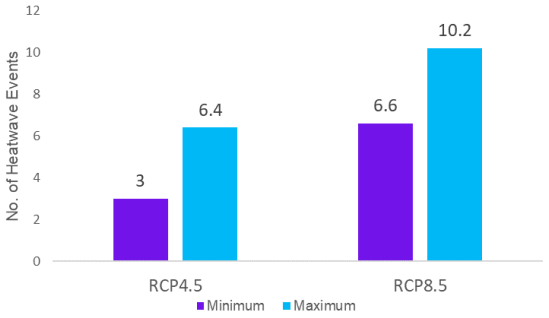
Climate Projections for County Wicklow in 2050 (1/2)

Having identified and assessed the range of climate hazards and impacts already experienced by County Wicklow, 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 County Wicklow may be exacerbated. The information below summaries the climate projections for each hazard based on Nolan and Flanagan (2020).

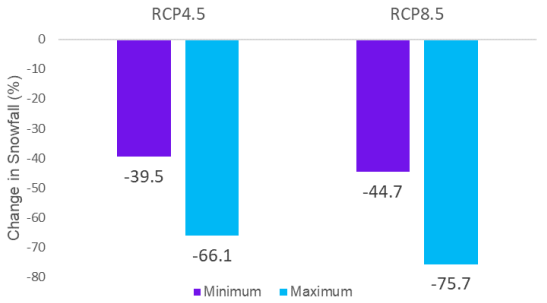
Hazard	Projected Change	Future Frequency
Heatwaves	• Projections indicate **an overall increase in average temperature** (bottom left) of between 1.2 and 1.6°C for County Wicklow relative to the 1981-2000 period. • Under a high emission scenario (RCP8.5), projections indicate that **heatwaves will become more frequent** (bottom middle) by mid-century.	Frequent ↑
Droughts	• **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	• As a consequence of the increasing temperatures, **a decrease in the number of frost days and ice days** in the 2041-2060 future period is projected when compared with the baseline period of 1981 to 2000.	Common ↓
Heavy Snowfall	• 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).	Common ↓
Severe Windstorms	• **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.	Very Frequent ▬



The projected minimum and maximum **change in the mean annual temperature** for the area of County Wicklow 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 Wicklow 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 **change in snowfall** for the area of County Wicklow 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)*

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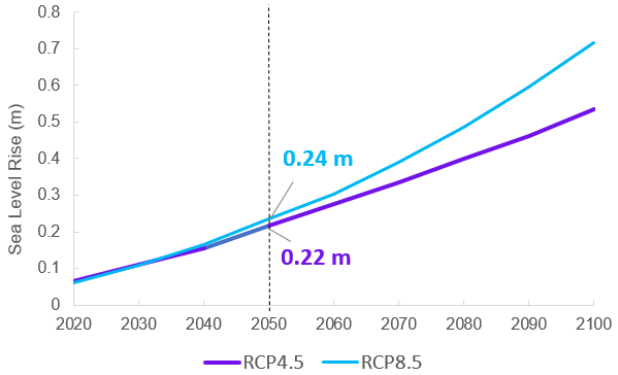
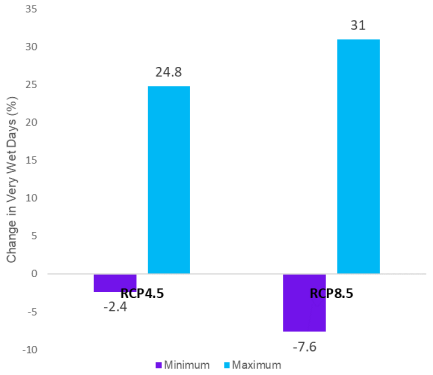
Climate Projections for County Wicklow in 2050 (2/2)

Having identified and assessed the range of climate hazards and impacts already experienced by County Wicklow, 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 County Wicklow may be exacerbated. The information below summaries the climate projections for each hazard based on Nolan and Flanagan (2020).

Hazard	Projected Change	Future Frequency
Coastal Flood	• Sea levels projections under a high emissions scenario indicate an increase of up to 0.24 m by 2050 which will **increase the frequency of coastal inundation** (bottom left).	Very Frequent
Coastal Erosion	• A rising sea level is strongly linked with coastal erosion and **an increase in erosion rates and extent.**	Very Frequent
Pluvial Flood	• Projections indicate an **increase in the frequency of heavy rainfall days** (days with precipitation >30mm) for County Wicklow with some areas projected to see increase of up to 90% (bottom right). This will likely result in an increased frequency of associated fluvial and pluvial flooding.	Very Frequent
River Flood		Very Frequent
Groundwater Flood	• Projections of changes in groundwater flooding are currently not available, therefore there is uncertainty in the change in groundwater flooding frequency that can be expected.	Occasional



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



The projected **change in very wet days (> 30 mm)** for County Wicklow 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)*

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

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Projected Changes in Exposure and Vulnerability

In the future, County Wicklow 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 Wicklow 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?

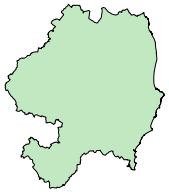
- Extra **1m population**, 500,000 in rural areas / regional centres
- Extra 660,000 jobs

- 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 Wicklow projected to change?



- Population of Wicklow to increase to **160,500-164,000** (NPF) in 2031
- **Bray population** targeted to increase by **c. 8,900** between 2016 and 2028. (CDP)
- **8,467 new housing units** required by 2028 (CDP)

CPO 4.2: *"To secure compact growth through the delivery of at least 30% of all new homes within the built-up footprint of existing settlements by prioritising development on infill, brownfield and regeneration sites and redeveloping underutilised land in preference to greenfield sites"*

Planning for adaptation

Coastal and Flood Defence Schemes:

The proposed Arklow Flood Relief scheme includes the construction of flood defences and an embankment on the Avoca River; including strengthening works to the existing quay walls and Arklow Bridge. The estimated cost is €20m - €50m.

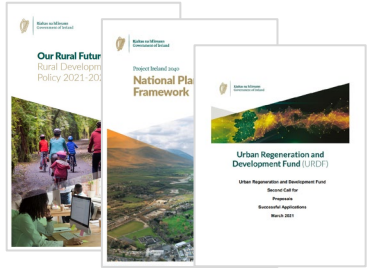
Key national road infrastructure projects include focus for council:

- N11/M11 Junction 4 to Junction 14
- N11 Parallel Service Road, Kilmacanogue
- N11/M11 Bus Priority Interim Scheme

Notable renewable energy initiatives include:

- 22 X Sustainable Energy Community (SEC) (e.g. Arklow SEC, Enniskerry SEC, Ballynagran Community)
- Offshore Wind Farms (e.g. Wicklow Offshore Wind Farm, Codling Wind Park – both in development phase)
- Solar farms, e.g. 85-hectare Millvale solar

Planning for mitigation



Case Study in Urban Planning: Bray Harbour Area Integrated Regeneration

- **€7.14 million** has been allocated to the regeneration of the Bray Harbour Area through **the Urban Regeneration and Development Fund (URDF)**
- The overall vision is to re-imagine and regenerate the strategically located waterfront area of Bray and to increase economic activity, amenity, and connectivity to public transport, the sea-front and esplanade.
- The plan includes an extension of the south breakwater to improve wave shelter within the harbour, and dredging of the inner harbour to increase available depths. Rock armour will be added to along the outer breakwater to reduce wave overtopping during storm condition.

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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 of assets. In order to estimate the potential change in risk, a number of assumptions have been made in relation to the seven categories of exposure, which are outlined below.

Assets	• Due to the expected increase in County Wicklow'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. • Due to the expected increase in the frequency of coastal erosion and coastal flooding, assets on the coastline will be more regularly exposed to erosion and flooding which will result in the washing away of the coastline and increased damage to assets along the coastline. • 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
Health and Wellbeing	• Due to the expected increase in the elderly population in County Wicklow 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
Environment	• The potential increasing occurrence of heatwaves and drought conditions within County Wicklow 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 Wicklow, there could be an **increase in the impact on environmental assets** as the time/ability for the habitat/environment to recover is reduced • Coastal Erosion and Coastal Flooding events will become more frequent. Consequently, environmental assets will be more frequently exposed to flooding and erosion hazards, and higher flood levels and more frequent erosion events will mean **environmental assets previously unaffected by flooding and erosion may become exposed-** resulting in short and long term damage to habitats/environment by these hazards

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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 of assets. 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	• Due to the expected increase in the total and elderly population in County Wicklow 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, anti social behaviour
Cultural Heritage	• Due to the potential increase in frequency of heatwave and drought events, **degradation rates will potentially increase resulting in an increase in the impact on cultural heritage assets.** • Coastal Erosion and Coastal Flooding events will become more frequent. Consequently, cultural heritage assets will be more frequently exposed to flooding and erosion hazards, and more frequent flood events will mean that cultural heritage assets previously unaffected by flooding may become exposed resulting in short and long term damage to cultural heritage assets by these hazards.
Financial	• Due to the potential increase in frequency of hazard events and exposure across County Wicklow, there will be an **increase in the associated 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	• Due to the potential increase in frequency of hazard events and exposure across County Wicklow 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 Wicklow, e.g. coastal erosion, 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**

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Future Impacts

Taking into account the changes in exposure and vulnerability, the future change in impacts for each of the ten 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**	Negligible	**Minor**	Minor	**Moderate**	Minor	**Moderate**
Drought	Negligible	**Minor**	Negligible	**Minor**	Minor	**Moderate**	Minor	**Moderate**	Minor	**Moderate**	Negligible	**Minor**	Negligible	**Minor**
Cold Spell	Moderate	Moderate	Moderate	Moderate	Negligible	Negligible	Moderate	Moderate	Minor	Minor	Moderate	Moderate	Minor	Minor
Heavy Snowfall	Minor	Minor	Moderate	Moderate	Minor	Minor	Moderate	Moderate	Negligible	Negligible	Minor	Minor	Minor	Minor
Severe Windstorm	Moderate	Moderate	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Moderate	Moderate	Moderate	Moderate
Coastal Flood	Moderate	**Major**	Minor	**Moderate**	Minor	**Moderate**	Minor	**Moderate**	Minor	**Moderate**	Minor	**Moderate**	Minor	**Moderate**
Coastal Erosion	Major	**Catastrophic**	Negligible	**Minor**	Moderate	**Major**	Moderate	**Major**	Moderate	Moderate	Major	Major	Major	Major
Pluvial Flood	Minor	**Moderate**	Minor	**Moderate**	Minor	**Moderate**	Minor	**Moderate**	Negligible	**Minor**	Moderate	**Major**	Moderate	**Major**
River Flood	Major	Major	Minor	**Moderate**	Minor	**Moderate**	Moderate	**Major**	Negligible	**Minor**	Moderate	**Major**	Moderate	**Major**
Groundwater Flood	Minor	Minor	None	None	Negligible	Negligible	Negligible	Negligible	None	None	Negligible	Negligible	None	None

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3.3.3 Future Climate Risk Matrix

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Future Climate Risk Matrix

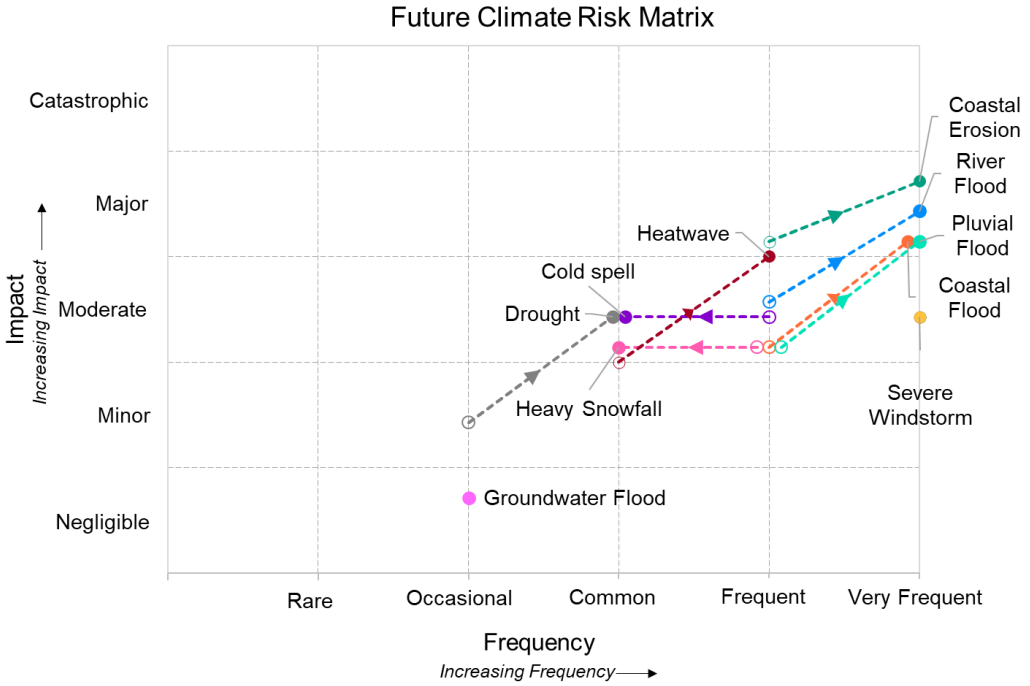
Projected changes in levels of hazard, exposure, and vulnerability for County Wicklow combine to form an assessment of future risks. The future climate risk matrix on the right shows projected change in risk with the hollow marker showing the current risk and the solid marker the future risk. The dotted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

The **risk** of existing hazards such as **river, pluvial, and coastal flooding and coastal 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 in increase in the areas, assets and populations exposed to these hazards.

Heatwaves and droughts although already experienced in County Wicklow, are expected to occur more frequently due to climate change and with a greater impact on County Wicklow in the future. The risk is exacerbated by not only projected changes in frequency occurrence of heatwaves and drought but also as a result of projected increases in population and the proportion of population considered vulnerable (those aged 65 years and over). These hazards can be therefore be considered as **emerging risks** 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 Wicklow. The risk of **groundwater flooding** is also unchanged in the future, however, there is uncertainty associated with how climate change will impact the occurrence of this hazard.

The impact of **heavy snowfall and cold spells** on County Wicklow 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 Wicklow. 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.

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3.3.4 Uncertainty Assessment

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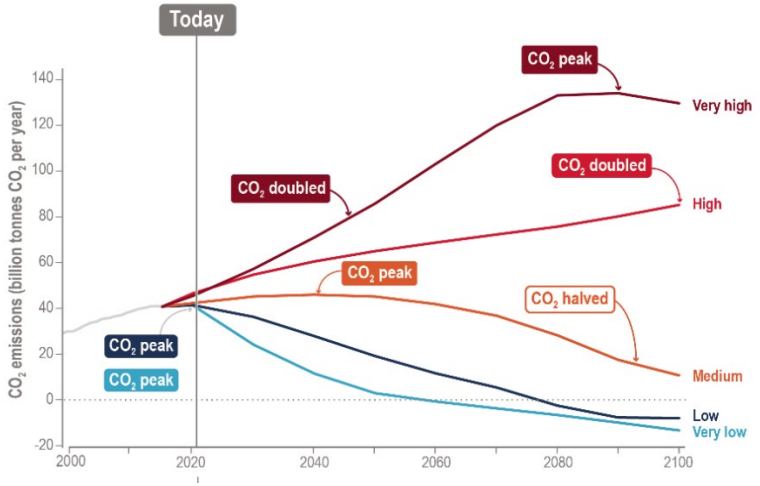
Uncertainty

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.

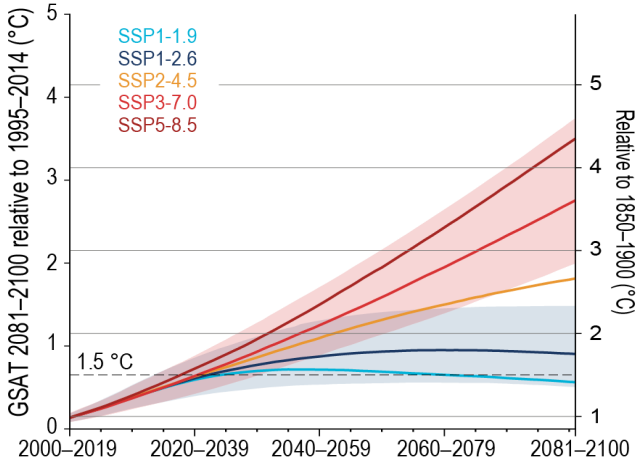
Different social and economic developments can lead to substantially different future emissions of carbon dioxide and other greenhouse gases (bottom left) resulting in uncertainty in what the future global climate will be. As an example of the possible future ranges in mean global surface temperature (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 Wicklow will develop into the future. Although, in the near-term there is relatively good understanding as a result of strategies, such as the Wicklow 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 CO_2 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).

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3.4 Summary

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Summary

This CCRA detailed within this report provides an assessment of the risks posed by climate change for County Wicklow and the implications of these risks for Wicklow County Council. The CCRA has been developed to support Wicklow County Council's efforts to prepare its LACAP and has been developed in line with the Local Authority Climate Action Plan Guidelines, Technical Annex B (2023). The key results are summarised below:

- **Coastal erosion and coastal flooding** pose a significant risk for County Wicklow and have resulted in damage to and loss of transport infrastructure (e.g. the eastern rail corridor), loss of coastal habitat (e.g. the Murrough), disruption of recreational infrastructure (e.g. Greystones to Bray Head), and inundation of buildings. Rising sea levels will increase the frequency of coastal inundation and rate of coastal erosion, resulting in an increased coastal erosion and flood risk for County Wicklow.
- Recent experiences of **river and pluvial flooding** events in 2020, 2021 and 2022, resulted in inundation of buildings, disruption of transport networks (e.g. M11), increased pressure on emergency services, and the issue of 'do not swim notices' due to increased surface water pollutants. Projected increases in the frequency of extreme precipitation events will result in increased surface water and riverine flood risk for County Wicklow.
- **Severe windstorms** are currently experienced on a frequent basis in County Wicklow and result in wide-ranging impacts, including damage to buildings and infrastructure, disruption to energy supply, and disruption of transport networks. Projections indicate no significant change to this frequency.
- County Wicklow experienced both a **heatwave and drought** in 2018, and 2022, with heatwaves also recorded in 2021. These events resulted in uncontrolled fires (e.g. Liffey Head and Lough Bray), increased demand placed on water resources, increased demand on recreational areas and detrimental impacts on freshwater quality and fish populations (e.g. Blessington Lakes algal blooms) Projected increases in the frequency of heatwaves and drought conditions will mean that events currently experienced on an infrequent basis will become more frequent. As the population ages, there will also be an increase in the number of vulnerable people exposed to heat-related risks.
- Recent experiences of **cold spells and heavy snowfall** events in 2018 (e.g. Storm Emma) demonstrated the wide range of impacts for County Wicklow. These included, amongst others, disruption to road networks (e.g. Sally Gap and N81), power outages, impacts on water resources (e.g. boil water notices) and impacts 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
- **Groundwater flooding** is currently experienced on an infrequent basis in County Wicklow and results in limited impacts associated with disruption of road of infrastructure. Projections indicate no significant change to this frequency.

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

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04
Appendices

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4.1
Appendix 1

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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

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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

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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.

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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

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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

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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

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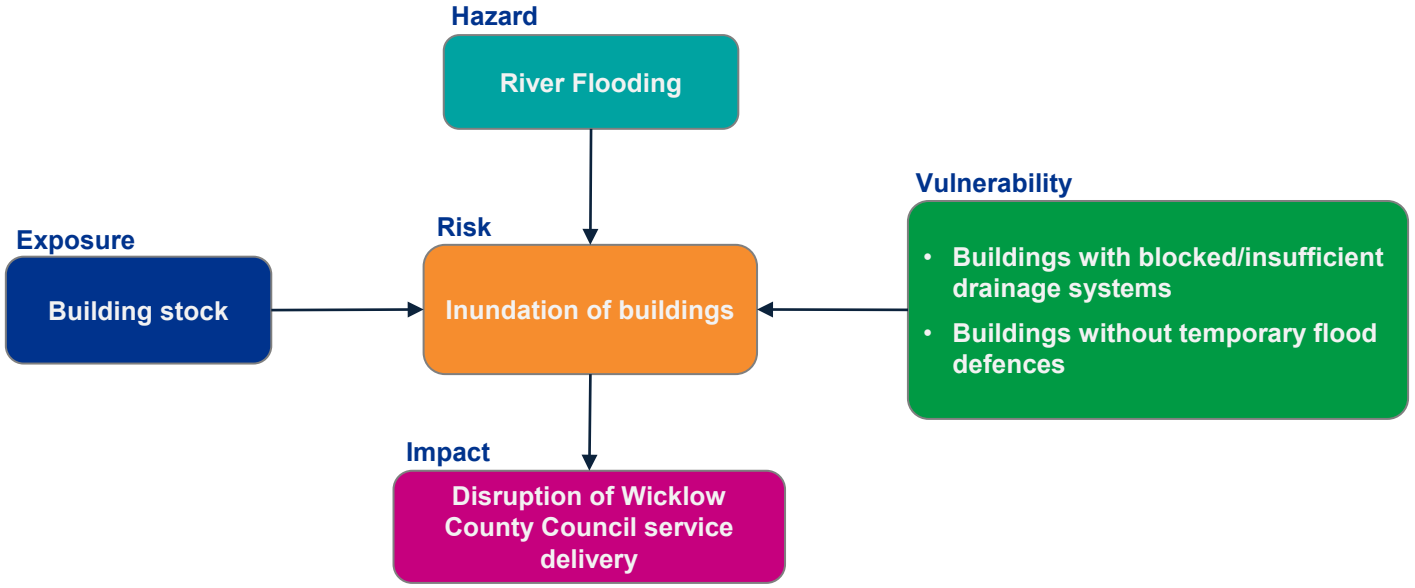
Characterising Exposure, Vulnerability and Impacts of Climate Hazards

For County Wicklow 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 Wicklow County Council buildings. The buildings with insufficient drainage and with no temporary flood defences would be considered more vulnerable to this hazard. Consequently, if Wicklow County Council buildings were to be flooded, one of the possible impacts would be the disruption of Wicklow 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 Wicklow County region.



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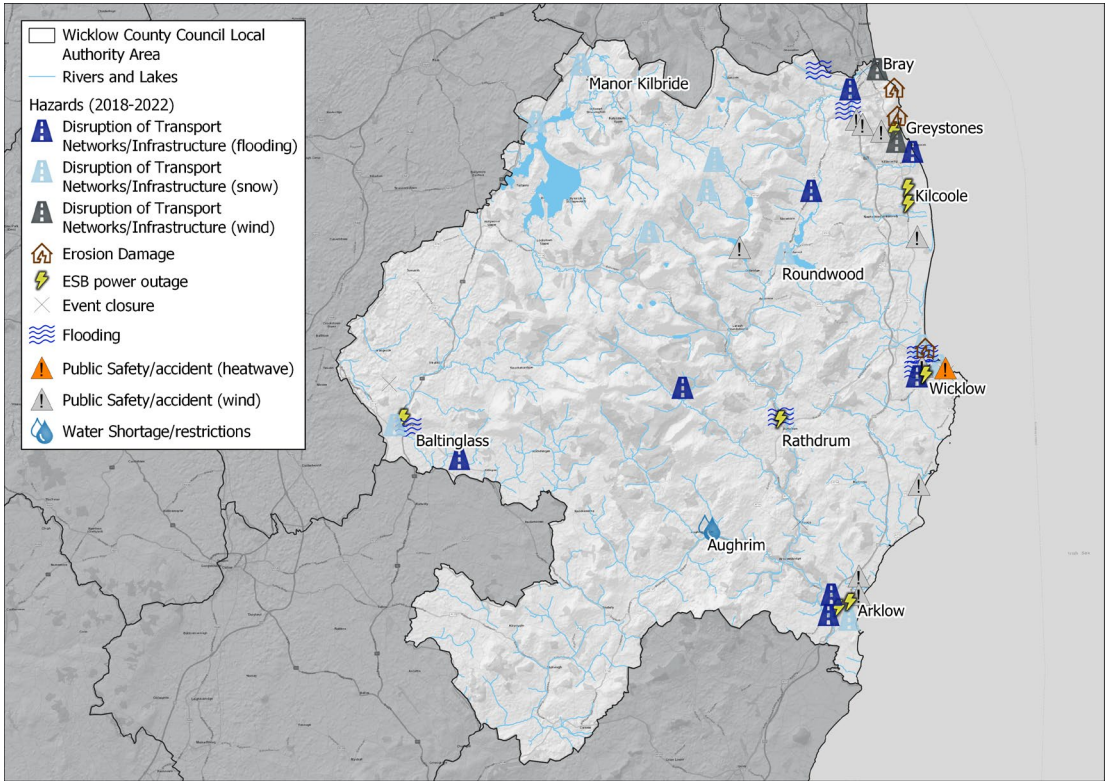
Exposure, Vulnerability and Impacts of Climate Hazards

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 in County Wicklow. Below and to the right we provide an example of exposures and impacts of hazard events experienced between 2018 and 2022.

- **Extreme precipitation** on Christmas Day 2021 wreaked havoc for many road users in Wicklow. The M11 at Junction 23/24, the R747 (Woodenbridge to Aughrim) and the Avoca Road in Rathdrum were closed due to road flooding.
- **Heavy snowfall** associated with **Storm Emma** in 2018 left the N81 and roads around Wicklow town, Arklow and Baltinglass areas impassable with metres of snow accumulating in some areas.
- **Coastal erosion** in March 2018 during Storm Emma led to large swathes of the Murrough being eroded away.
- **Extreme precipitation** in March 2021 caused disruption to recreational activities as the Cliff Walk between Bray and Greystones was closed following a number of landslides after the heavy rainfall.
- A **cold spell in** December 2022 caused disruption for road users with the Sally Gap declared impassable due to severe ice on the roads.
- A **severe windstorm** in January 2023 left almost 2,000 ESB customers without power. Winds of over 50 km/h caused damage to energy supply.
- Traffic came to a standstill on roads by the South Beach in Greystones after **extreme precipitation** overnight led to **flash flooding** in the area in October 2022.



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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	• Hot and uncomfortable working/living conditions • Increased demand on recreational areas • Damage to road surface and hazardous driving conditions. • Disruption of public transport networks • 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 • Increase in the frequency of uncontrolled fire • Disruption of recreational activities • Increased strain on natural biodiversity	• Housing, buildings (including LA offices), care home/leisure centres/recreational facilities (elderly population), outdoor workers (workers with limited access to water, shade and sunscreen) • Bathing areas, parks (with easy access to urban areas) • Local roads (surface-dressed roads, located in areas of high solar radiation) • National railway network (communities with limited transport network) • Pasture (marginal farm incomes) • Reservoirs/lakes (sites with deteriorated water quality/eutrophic status) • Emergency response services (Areas of growing vegetation) • Recreational areas (areas with diverse wildlife populations) • European/Irish designated sites (SPAs, SACs, Ramsar sites, NHAs) (areas with diverse wildlife populations)
Drought	• 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	• Pasture (farmers at risk of marginal farm incomes) • Reservoirs/lakes/groundwater supplies (lakes already depleted/under stress) • Cultural heritage • Biodiversity (areas with diverse wildlife populations)

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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	• Extreme cold results in increased requirement for heating and associated economic costs • Cold conditions result 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 infrastructure • Impacts on water resources • Increases in cold-related mortality and morbidity • Delay of infrastructure/development projects • Increased strain on natural biodiversity • Damage to built heritage • Damage and disruption of electricity supply	• Buildings (poorly insulated, with elderly residents, in isolated locations) • Public/private transport vehicles (exposed vehicles not suited to cold conditions) • Transport network (road and rail) (untreated road surfaces, near isolated communities) • Road network (isolated and vulnerable communities) • 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), reservoirs/ lakes • People at high risk of exposure to cold (people in insulated buildings, vulnerable communities) • Development projects (ongoing construction with loose materials) • European/Irish designated sites (SPAs, SACs, Ramsar sites, NHAs) • Built Heritage (in more exposed locations) • Homes/businesses/local govt office (without on-site electricity generation)
Heavy Snowfall	• Damage to buildings • Disruption of 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	• Buildings (elderly residents), offices (incl. LA) (impervious surfaces) • Transport networks (communities with limited transport options) • Agricultural sites (livestock unprotected) (farms at higher elevations) • Energy supply (energy infrastructure in need of maintenance, older infrastructure) • Employers, employees, customers, students (business located in low-lying areas) • Waste collection routes (in terrain with a higher propensity of snow drifts) • Natural resources/sensitive materials/water supply (environmentally sensitive areas - terrestrial and aquatic (e.g. Ramsar sites)) • Areas prone to flooding (areas with inadequate drainage)

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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)
Severe Windstorm	• Direct wind damage to buildings and infrastructure • Disruption of communications infrastructure • Wind damage to trees resulting in tree fall • Wind damage to habitats and sensitive species • Treacherous conditions at coast and on land • Disruption of wind energy generation • Disruption to energy supply • Disruption of transport networks • Disruption to waste collection • Disruption to water quality monitoring • Closure of parks and public buildings	• Buildings, development sites (buildings w. vulnerable populations) • Overhead communication lines (situated in upland and exposed sites) • Trees (forestry situated in upland and /or exposed areas) • Habitats and sensitive species (habitats and tree species already under stress) • Coastal and uplands areas (areas in exposed locations) • Wind turbines (turbines with lower shut-down thresholds for high winds) • Distribution network (energy infrastructure situated in exposed locations or in close proximity to trees) • Road and rail network (in exposed locations) • Waste collection routes (routes in exposed locations) • Waterbodies (exposed water bodies) • Parks/public buildings (populations requiring essential council services, in exposed locations)
Groundwater Flood	• Inundation and damage to road infrastructure which can result in isolation of communities • Farmland inundation	• National road (roads with limited drainage capacity) • Farmland situated in areas of groundwater flood risk (farmlands situated in close proximity to seasonal lakes, i.e. torloughs)

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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	• Temporary inundation of buildings • Deterioration of transport infrastructure • Closure/submergence of transport routes and impact on commuting, accessibility and travellers • Flooding of agricultural areas • Damage to recreational amenities and facilities provided by the council • Damage to coastal habitat • Accessibility of islands communities • Damage to wastewater infrastructure • Potential coastal bridge failure	• Housing buildings, heritage sites (located in low lying coastal areas) • Coastal road and rail infrastructure (roads and rail situated in low-lying coastal areas) • Agricultural areas (farms on marginal income) • 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) • Island transport infrastructure (habitable island areas without safe harbours) • Wastewater treatment plants (water restrictions, boil water notices and bathing water notices) • Bridges (bridges in need of investment for scour protection to abutments and piers)
Coastal Erosion	• Deterioration of transport and subterranean infrastructure • Disruption and loss of transport infrastructure • Damage to and loss of recreational amenities • Damage to and loss of coastal habitat • Damage to heritage sites	• Coastal roads and rail infrastructure (roads used for commuting purposes and by isolated communities and students) • Public/Staff (road and rail situated in 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 (sites exposed to existing coastal erosion)

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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	• 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	• Buildings, local authority offices, heritage sites (blocked drainage systems, high levels of impervious surfaces, etc) • Recreational amenities (low-lying parks and other amenities) • Stormwater infrastructure (areas where these is a lot of un-reinforced waste management systems containing potential debris (natural/man-made)) • Road/railways (low-lying roads and railways with no alternative access routes and which allows for the pooling of water) • 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	• 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	• Buildings, local authority offices, heritage sites (older buildings which where stone cavities are at risk of soakage and leakage) • Recreational amenities (low-lying parks, located near water bodies, parks and amenities in need of investment) • Stormwater infrastructure, people (river backs 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 carparks, 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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