Climate Change Risk Assessment

Part of the Cork City
Climate Action Plan 2024–2029

Comhairle Cathrach Chorcaí
Cork City Council

Contents

Comhairle Cathrach Chorcaí
Cork City Council

1

Executive Summary

Photo: Mike Hannen

Context and Scope of this Report

Climate change poses a critical challenge for Cork City. It will result in a wide range of impacts across the city, from damaging infrastructure such as buildings and roads, to increased pressure on emergency services, and limiting water supply. These impacts will bring substantial implications for Cork City 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 national climate policy to the local level.

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

Key results and findings

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

Recent experiences of **tidal flooding** in 2020, and 2021, resulted in the submergence of transport routes, damage to automobiles (e.g. Morrison's Island), inundation of buildings, and increased pressure on emergency services. Rising sea levels will increase the frequency of tidal inundation, resulting in an increased flood risk for Cork City.

Coastal erosion is currently not considered a risk for Cork City. How ever, projected increases in sea level may result in an increased level of risk for coastal habitats (e.g. Cork Harbour Ramsar Site).

Severe windstorms are currently experienced on a very frequent basis in Cork City and result in wide-ranging impacts, including damage to buildings and infrastructure (e.g. Kent Station), disruption to energy supply, and disruption of transport networks. Projections indicate no significant change to this frequency.

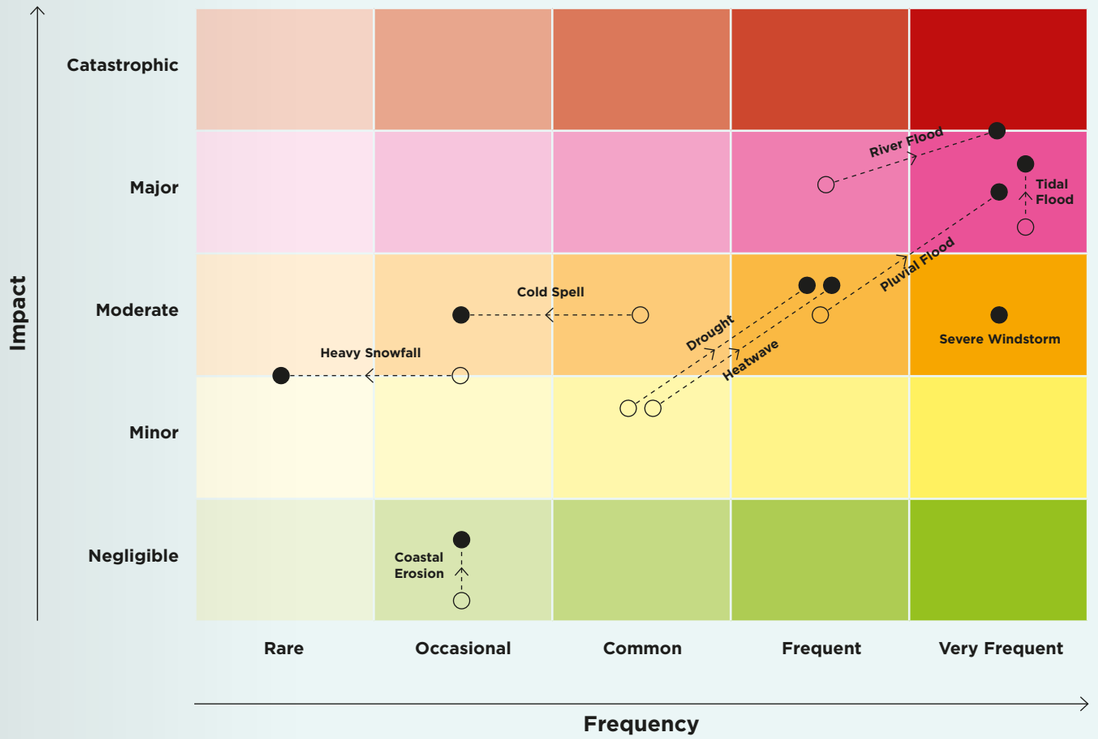
Pluvial and fluvial flooding already pose a significant risk for Cork City and have resulted in the inundation of homes (e.g. Glanmire) and buildings (e.g. Douglas Shopping Centre), disruption of transport networks (e.g. South City Link Rd.), increased pressure on emergency services (e.g. evacuation of residents in 2009), and the closure of public amenities (e.g. Mardyke Arena). Projected increases in the frequency of extreme precipitation events will result in increased surface water and riverine flood risk for Cork City.

Cork City experienced both a **heatwave and a drought** in 2018, with heatwaves also recorded in 2022. These events placed an increased demand on water resources, and also put increased pressure on recreational areas (e.g. the Lough). Projected increases in the frequency of heatwaves and drought conditions will mean that events currently experienced on a common basis will become more frequent.

Recent experiences of **cold spells and heavy snowfall** events in 2018 (e.g. Storm Emma) and 2022 demonstrated the wide range of impacts for Cork City. These included, amongst others, damage to water infrastructure and disruption of supply, cancellation of public transport, 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 snow fall, and their associated impacts.

Future climate risk

To increase resilience, Cork City 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 Cork City.

○ *hollow marker shows the current level of risk*

● *solid marker the future level of risk.*

--- *dotted line shows the change between the current and future risk.*

2

Introduction

Global Response to the Challenge of Climate Change

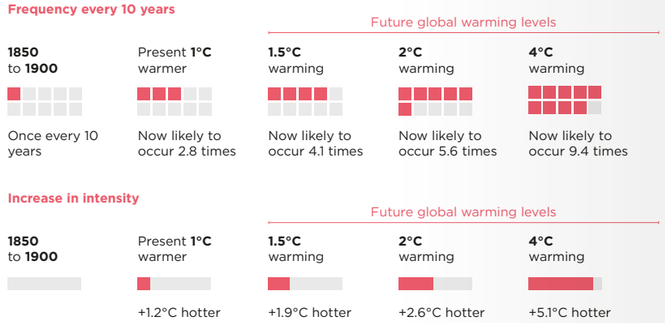
It is unequivocal that human influence has warmed the atmosphere, land and ocean since pre-industrial times, affecting many weather and climate extremes in every region across the globe. Each of the last four decades has been successively warmer than any decade that preceded it since instrumental records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

Extreme heat becomes more frequent

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



Source: IPCC, 2021: Summary for policy makers

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

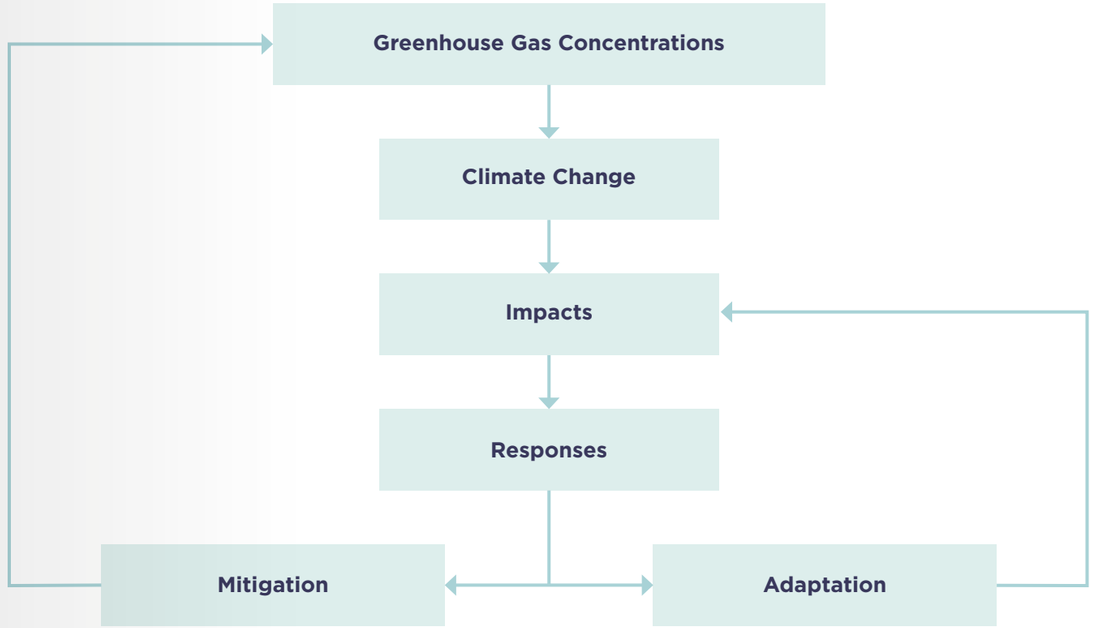
Making the impacts of climate change less severe by preventing or reducing the emission of greenhouse gases (GHGs) into the atmosphere. Mitigation is achieved either by reducing the sources of these gases (e.g. by increasing the share of renewable energies, or establishing a cleaner mobility system) 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.



Ireland's challenge of Climate Change

Observed Impacts

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

Climate projections indicate that observed changes in Ireland's climate will continue and 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. the process of adjusting to the current and future effects of climate change.

- 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

International, European, and National 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:

1. 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**);

2. 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 2023

The 6 Vital High Impact Sectors

Powering renewables

75%

reduction in emissions by 2030

We will facilitate a large-scale deployment of renewables that will be critical to decarbonising the power sector as well as enabling the electrification of other technologies.

- Accelerate the delivery of onshore wind, offshore wind, and solar.
- Dial up to 9 GW onshore wind, 8 GW solar, and at least 7 GW of offshore wind by 2030 (with 2 GW earmarked for green hydrogen production).
- Support at least 500 MW of local community-based renewable energy projects and increased levels of new micro-generation and small-scale generation.
- Phase out and end the use of coal and peat in electricity generation.
- New, dynamic Green Electricity Tariff will be developed by 2025 to incentivise people to use lower cost renewable electricity at times of high wind and solar generation.

Building better

45% commercial

40% residential

reduction in emissions by 2030

We will increase the energy efficiency of existing buildings, put in place policies to deliver zero-emissions new builds and continue to ramp up our retrofitting programme.

- Ramp up retrofitting to 120,000 dwellings to BER B2 by 2025, jumping to 500,000 by 2030.
- Put heat pumps into 45,000 existing and 170,000 new dwellings by 2025, up to 400,000 existing and 280,000 new dwellings by 2030.
- Generation up to 0.8 TWh of district heating by 2025 and up to 2.5 TWh by 2030.

Turning transport around

50%

reduction in emissions by 2030

We will drive policies to reduce transport emissions by improving our town, cities and rural planning, and by adopting the Avoid-Shift-Improve approach: reducing or avoiding the need for travel, shifting to public transport, walking and cycling and improving the energy efficiency of vehicles.

- Change the way we use our road space.
- Reduce the total distance driven across all car journeys by 20%.
- Walking, cycling and public transport to account for 50% of our journeys.
- Nearly 1 in 3 private cars will be an Electric Vehicle.
- Increase walking and cycling networks.
- 70% of people in rural Ireland will have buses that provide at least 3 trips to the nearby town daily by 2030.

2 - Introduction

Making family farms more sustainable

25%

reduction in emissions by 2030

We will support farmers to continue to produce world-class, safe and nutritious food while also seeking to diversify income through tillage, energy generation and forestry.

- Significantly reduce our use of chemical nitrogen as a fertilizer.
- Increase uptake of protected urea on grassland farms to 90-100%.
- Increase organic farming to up to 450,000 hectares, the area of tillage to up to 400,000 ha.
- Expand the indigenous biomethane sector through anaerobic digestion, reaching up to 5.7TWh of biomethane.
- Contribute to delivery of the land use targets for afforestation and reduced management intensity of organic soils.

Greening business and enterprise

35%

reduction in emissions by 2030

We're changing how we produce, consume, and design our goods and services by breaking the link between fossil fuels and economic progress. Decarbonising industry and enterprise is key to Ireland's economy and future competitiveness.

- Reduce clinker content in cement and substitute products with lower carbon content for construction materials, ensuring 35% reduction in emissions by 2030 (against 2018).
- Reduce fossil fuel use from 64% of final consumption (2021) to 45% by 2025 and further by 2030.
- Increase total share of heating to carbon neutral to 50-55% by 2025, up to 70-75% by 2030.
- Significantly grow the circular economy and bioeconomy.

Changing our land use

TBD

exact reduction to be determined

The first phase of the land use review will tell us how we are using our land now. Then, we can map, with evidence, how it can be used most effectively to capture and store carbon and to produce better, greener food and energy.

- Increase our annual afforestation rates to 8,000 hectares per annum from 2023 onwards.
- Rethink our Forestry Programme and Vision. Promote forest management initiatives in both public and private forests to increase carbon sinks and stores.
- Improve carbon sequestration of 450,000 ha of grasslands on mineral soils and reduce the management intensity of grasslands on 80,000 ha of drained organic soils.
- Rehabilitate 77,600 hectares of peatlands.

Project Overview

Legaslative Context

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

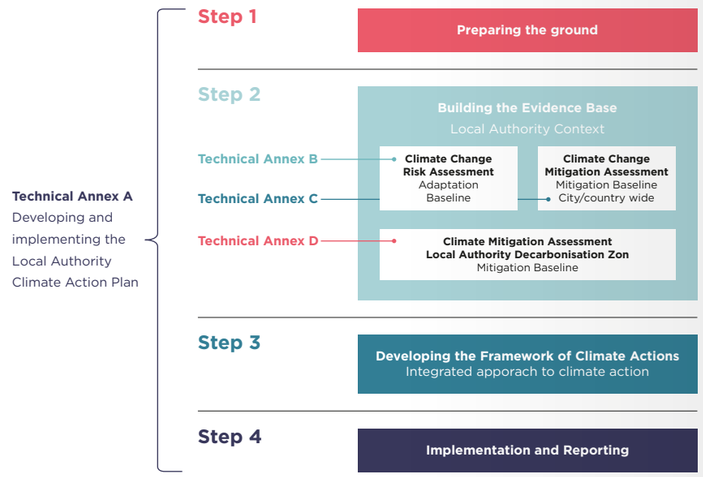
The importance of place-based approaches and the role of the Local Authority is highlighted in the Act, which stipulates that "each local authority shall prepare and make a plan relating to a period of five years (in this section referred to as a 'local authority climate action plan') which shall specify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

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

Preparing local authorities' climate action plans

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

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



Scope of this report

Step 2 in the LACAP is 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 Cork City and the implications of these for Cork City Council.

2 - Introduction

3

Climate Change Risk Assessment Methodology

3.1

Introduction, Scope and Methodology

Understanding of Climate Change Risk Assessment

Purpose of Climate Change Risk Assessment

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

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

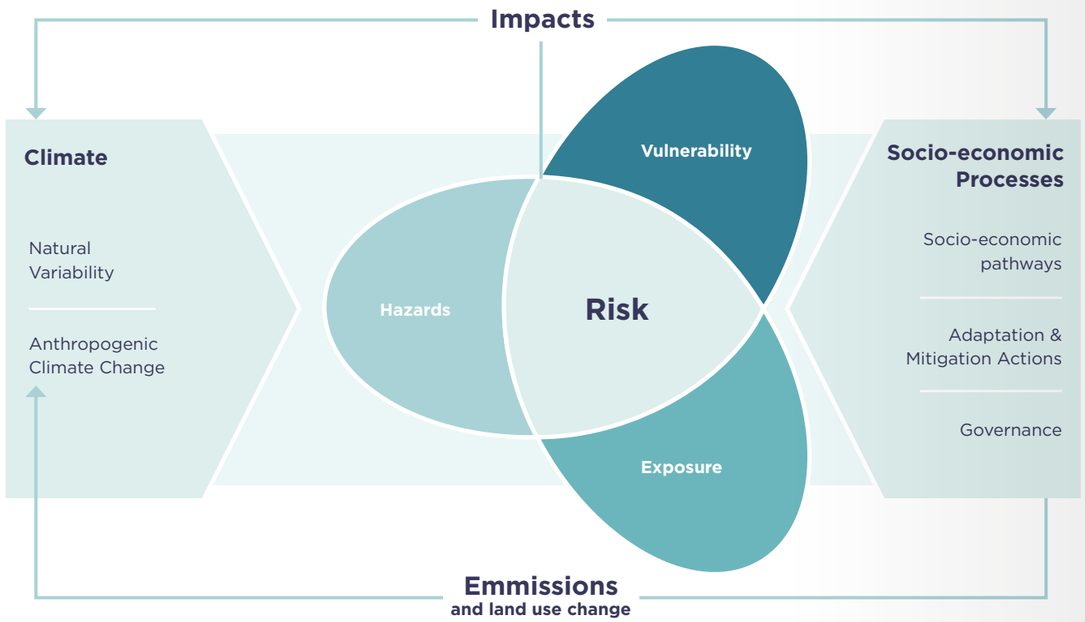
Photo: Zihao Chen / Unsplash

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 Cork City Council, the risk assessment framework of the Intergovernmental Panel on Climate Change (IPCC) has been adopted. This framework identifies three key components of climate risk: hazard, exposure and vulnerability. Details of the framework are provided on the next page.

Risk assessment framework of the Intergovernmental Panel on Climate Change (IPCC)



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.

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.

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

Methodology Climate Change Risk Assessment (CCRA)

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 Cork City.

Qualitative Assessment

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

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

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

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

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

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

Qualitative

A qualitative assessment is developed based on readily available information and provides for a screening of climate change related hazards and risks.

This type of assessment helps to:
- Identify the full range of climate-related risks;
- Communicate identified risks to relevant stakeholders;
- Prioritise risks for further more detailed analysis; and
- Provide a broad understanding of where adaptation actions could be required.

Semi-quantitative

A semi-quantitative risk assessment builds upon a qualitative screening assessment and provides a more detailed assessment of climate change risks. Semi-quantitative risk assessments use national and regional information and data along with expert judgement to explore potential risks in further detail.

This type of assessment helps to:
- Provide semi-quantitative risk analysis insights;
- Identify on a spatial basis climate risk hotspots;
- Identify where adaptation measures may be required.

Quantitative

A quantitative risk assessment uses site-specific data and expert knowledge to establish a detailed understanding of risks and identify the point in time in the future when the risk will pass the tolerable limit and when implementation of action will be necessary.

This type of assessment helps to:
- Detail an estimation of rate of change (when the risk will cross the limit and need action); and
- Identify the extent of impact (how badly it will affect the system).

Methodology Overview

As detailed below, **Technical Annex B Climate Change Risk Assessment** provides for a proportionate and stepped approach for undertaking a Tier 1 qualitative Climate Change Risk Assessment.

An assessment of the current climate hazards, exposure, vulnerabilities and impacts is first undertaken and this leads to an understanding of **'Current Climate Risks and Impacts'**.

This is followed by an assessment of potential **'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 Cork City
- Impact Assessment (Service Delivery)
- Current Climate Risk Matrix

Step 2
Future Climate Risks and Impacts

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

Step 1
Assess Current Climate Risks and Impacts

In assessing current climate risks and impacts, developing an understanding of the range of climate and weather related events currently Cork City and the consequence of these for Cork City 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 Cork City.

We have updated the climate hazard profile developed through the existing Cork City 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 Cork City

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

Section 3.2.2

1.4
Impact Assessment (Service Delivery)

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

Section 3.2.3

1.5
Current Climate Risk Matrix

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

Section 3.2.4

Step 2
Assess Future Climate Risks and Impacts

Building on the assessment of current climate impacts, assessing future climate risks and impacts is concerned with understanding and characterising how projected changes in the frequency and intensity of climate hazards may exacerbate existing climate impacts and risks for Cork City. 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 3.3.1

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 Cork City have been identified and considered as part of the CCRA.

Section 3.3.2

2.4 Future Climate Risk Matrix

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

Section 3.3.3

2.5 Uncertainty Assessment

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

Section 3.3.4

Data and Information Sources

As detailed below, a wide range of qualitative and quantitative and information was employed to inform the development of the CCRA for Cork City Council. The Cork City 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, Cork City Development Plan 2022-2028 and the Regional Spatial and Economic Strategy for the Southern Region were employed to assess future development patterns. In addition, two stakeholder workshops were held to garner further insights from Cork City Council.

Report Section	Sources	
Introduction and scope	Local Authority Climate Action Plan Guidelines, Technical Annex.	
Step 1: Current Climate Risks and Impacts	• Afloat.ie • Cork Beo • Cork CC Climate Change Adaptation Strategy • Cork CC website • Cork Safety Alerts • Echo Live • EPA • Flood Info • Inside Ireland • Irish Examiner	• Irish Independent • Irish News • Irish Times • Journal.ie • Lower Lee (Cork City) Flood Relief Scheme • Met Éireann • Newstalk • RTE News • UCC Express • UCC Report on Flood Damage
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	• High-resolution Climate Projections for Ireland – A Multi-model Ensemble Approach (Nolan and Flanagan, 2020) accessed via Climate Ireland • National Planning Framework population projections

3.2

Current Climate Risks and Impacts

Photo: Yves Alarie / Unsplash

3.2.1

Profile of Climate Hazards (incl. Frequency)

3.2.1 - Profile of Climate Hazards

Characteristics of Cork City

Cork City is located in the southern region and in the province of Munster, covering an area of 187 km^2. According to the Census 2022, Cork City Council serves 222,333 people (2022 Census). The city is known for its distinctive character which is a combination of its natural and built form.

Physical & Environmental Characteristics

Cork City has total area of approximately 187 km^2 making it the second largest city in the Republic of Ireland. The city is built on estuarine islands in the marshy valley of River Lee, expanding up to the steep hills rising to the north and south of the city centre and then into its hinterland.

Cork City's natural heritage includes flora, fauna, geology and landscape. There are approx. 1,200 protected structures in Cork City which are of historic, architectural or other significance. There is one Special Protected Area in Cork City, Cork Harbour with an approx. area of 2,660 ha, 11 National Heritage Areas, and no SACs within Cork City Council boundary. The River Lee runs through the city.

Cork City Council boundary was expanded in 2019. It now includes areas such as Model Farm Road, Fairhill, Ballyvolane, Glasheen, Wilton, Ballinlough, and Blackrock village which all became part of the extended city.

The city has multiple buildings, bridges, and monuments of architectural interest. The English Market,, Crawford Art Museum and Fitzgerald's Park are among the list of attractions. There is a wide array of parks, walkways and open spaces and Cork City Council maintains a total of 607 ha of these recreational and leisure assets.

Photo: Mike Hannon

Socioeconomic Characteristics

As of the 2022 Census, Cork City has a population of 224,004 people (2016, 210,853) which represents an increase of 13,151 (approx. 6.2%) since 2016.

The city suburbs naturally divides into four geographical areas: North West Suburb, North East Suburb, South East Suburb and South West Suburb. There are four urban towns in Cork City, each with a population of greater than 2,000: Ballincollig, Glanmire, Tower, and Blarney. Ballincollig has a population of 18,159 and has a significant tech-business employment base, being home to both VMware and Dell EMC. Glanmire has a population of 9,903 and is located in the northeast of the city, north of Tivoli Ridge. Tower has a population of 3,274 and is situated in the northwest corner of the city, 11 km from the city centre. Blarney has a population of 2,550 and is located in the northwest of the city, 8 km from the city centre.

The historic Blarney Castle and the former Woolen Mills are the focal points for the town drawing a large number of tourists annually. The City Hinterland (made up of the lands outside the City Centre, the City suburbs, and the four urban towns) has a population of 10,521.

Cork City has regional, national, and international connectivity through its airport, deep water port facilities and motorway linkages. Cork Airport is located to the south of the city and it is the second-largest of Ireland's three principal international airports.

The airport acts as a central hub for the city, metropolitan and region from a transport, connectivity and economic view point. It welcomed 2.24 million passengers in 2022. The adjoining Cork Airport Business Park is a large scale employment base within the region and is home to a wide range of businesses.

Cork City has a total of 463 km of road network which includes 44 km of regional roads and 419 km of local roads.

The Port of Cork is the world's second-largest natural harbour and is a key international gateway for trade. Due to its modern deep water facilities, the Port of Cork is ideally positioned for European trading. Kent train station operates as a hub for Intercity services to Dublin and Tralee and commuter services to Mallow, Cobh and Midleton.

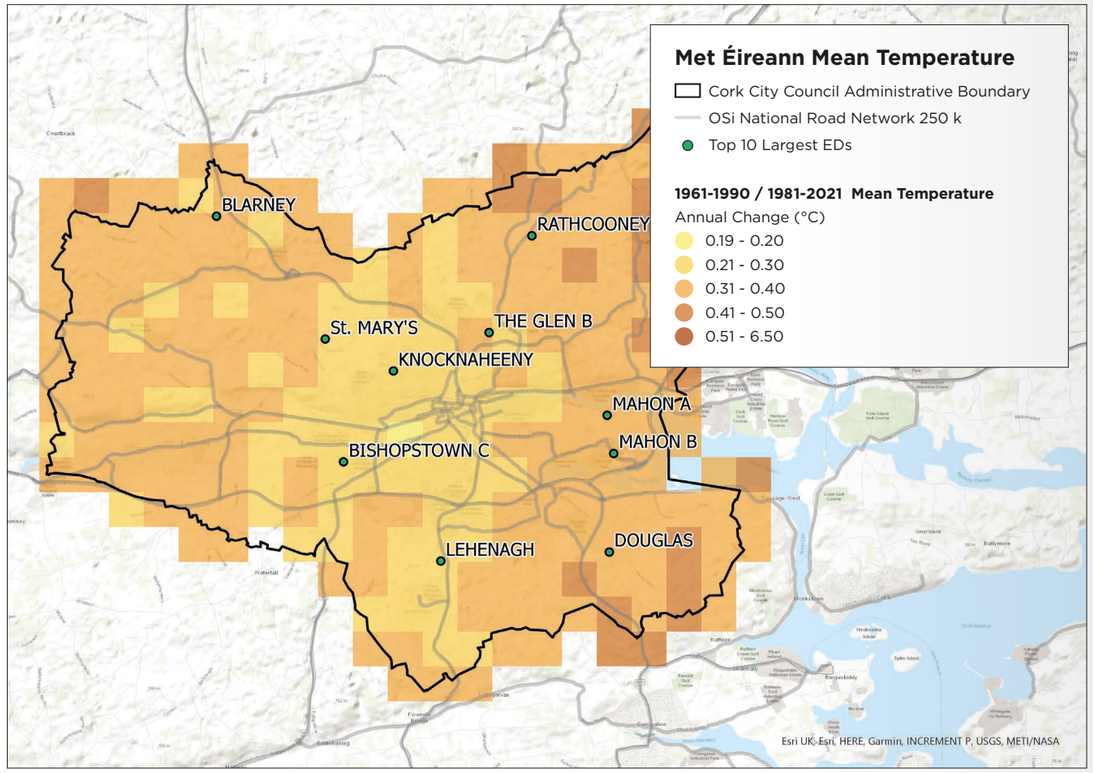
The total number of dwellings in Cork City increased by 89.2% from 2018 to 2020. Cork City is the largest city in the Southern region which contributes 19% of national GDP and generates the highest revenue per person in Ireland (€105,000) ahead of both Dublin (€96,000) and London (€104,000).

194 multinational firms are present in Cork operating across sectors such as pharmaceuticals, technology, cybersecurity, and financial services employing almost 43,000 people. There are more than 36,000 students enrolled in various disciplines in Cork City's third level colleges.

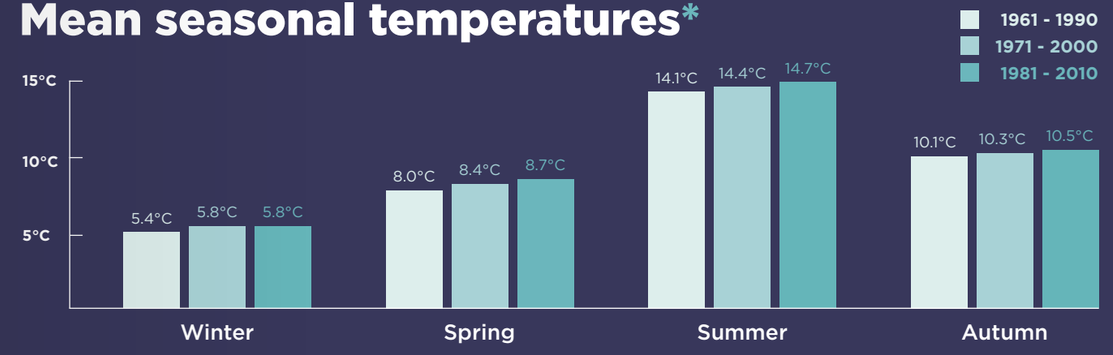
Observed Changes in Cork City's Climate

To assess changes in climatic conditions across Cork City, 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. For Cork City, we have employed data from Cork Airport to determine long-term climatologies.

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



Mean seasonal temperatures*



300 Floods

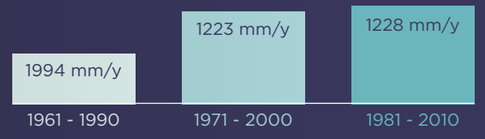
Cork City has experienced approx. 300 flood events since 1841**

0.5°C

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

Rainfall

Average annual rainfall at Cork Airport has increased by 2.8% for the most recent period (1981-2010) compared to the 1961-1990 baseline



5 of the top 10 wettest years on record since 1962 within Cork City have occurred since the year 2000*

€100m

The River Lee flooding of 2009 caused major disruption and over €100M worth of damages in Cork City, including the loss of running water to 50,000 people***

28.7°C

Highest temperature on record for Cork City, recorded on July 14th 1983 at Cork Airport weather station****

* *Source: Met Éireann Long term weather station : Cork Airport*
** *Source: Reachout-cities.eu*
*** *Source: Independent.ie*
**** *Historical Data - Met Éireann - The Irish Meteorological Service*

Climate Hazard Profile

In addition to observed changes in Cork City's climate, we have identified significant climate and weather-related events to have impacted on the city over the period 1987-2022. To do this, we have further developed the climate hazard profile developed through the Cork City Council Adaptation Strategy (2019) and expanded the analysis to cover the period 2018-2022.

1987 | | | **1990** | | | **1993** | | | **1996** | | | **1999** | | | **2002**

Snow & Ice

- Snowfall, Jan '87

Coastal

- Tidal Flooding, Feb '90
- Tidal Flooding, Jan '93
- Tidal Flooding, Feb '02

Heat & Cold

- Heatwave, Summer '95

Wet & Dry

- River Flooding, Aug '97
- River Flooding, Nov '00

Wind

- Severe Windstorm, '88
- Severe Windstorm, Jan '91

Colour coding of climate and weather related events

- Snowfall
- Tidal Flooding
- Heatwave
- Cold Spell
- River Flooding
- Pluvial Flooding
- Drought/Dry Spell
- Storm
- Hurricane

2005 | | | **2008** | | | **2011** | | | **2014** | | | **2017** | | | **2020**

Snow & Ice

- Snowfall, Feb-Mar '18

Coastal

- Tidal Flooding, Feb '14
- Tidal Flooding, Nov '19
- Tidal Flooding, Oct '20
- Tidal Flooding, Dec '21

Heat & Cold

- Heatwave, Summer '06
- Cold Spell, Jan '09
- Cold Spell, Jan '10
- Cold Spell, Mar '18
- Heatwave, Summer '18
- Cold Spell, April '19
- Heatwave, Aug '20
- Heatwave, Aug '22
- Cold Spell, Dec '22

Wet & Dry

- River Flooding, Aug '08
- River Flooding, Nov '09
- River Flooding, Feb '10
- River Flooding, Jun '12
- Pluvial Flooding, Jun '12
- River Flooding, Dec '12
- River Flooding, Feb '14
- River Flooding, Dec '15
- River Flooding, Apr '18
- Drought, Summer '18
- River Flooding, Oct '19
- Dry Spell, Aug-Sept '20
- River Flooding, Feb '21
- Pluvial Flooding, Sep '22
- Pluvial Flooding, Oct '22
- Pluvial Flooding, Dec '22

Wind

- Storm Darwin, Feb '14
- Hurricane Ophelia, Oct '17
- Storm Ali, Sep '18
- Storm Callum, Oct '18
- Storm Diana, Nov '18
- Storm Deirdre, Dec '18
- Storm Hannah, Apr '19
- Storm Brendan, Jan '20
- Storm Dennis, Feb '20
- Storm Ellen, Aug '20
- Storm Barra, Dec '21
- Storm Eunice, Feb '22
- Storm Franklin, Feb '22

Frequency of Climate Hazards

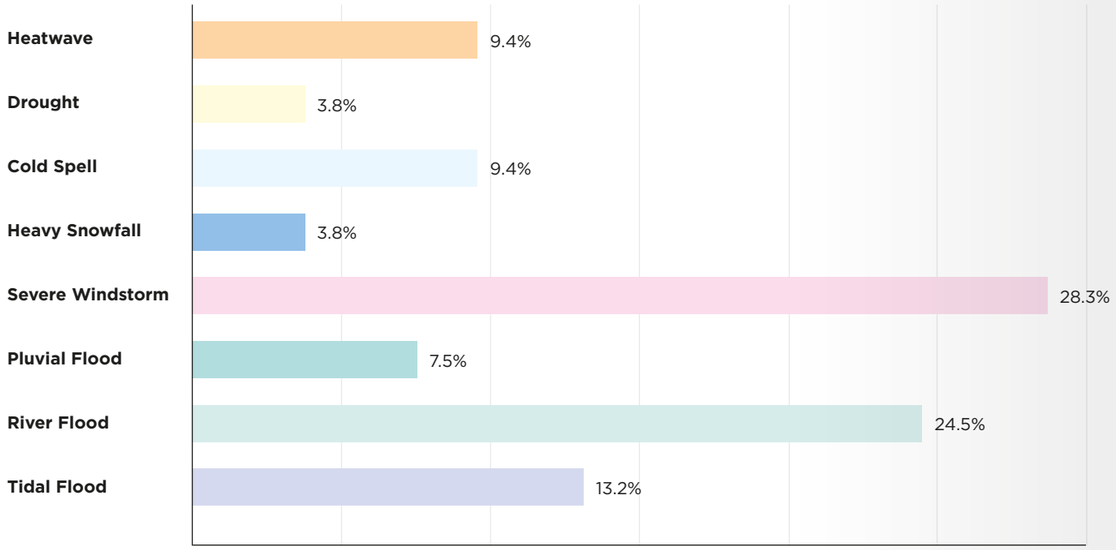
For each of the climate hazards that have been identified through the climate hazard profile, an assessment of their frequency of occurrence has been conducted.

Each hazard was assigned a frequency category according to Table 2 of the **Technical Annex B Climate Change Risk Assessment Guidelines** (next page).

Based on the climate hazard baseline, storm events have impacted upon Cork City most frequently over the period 1987-2022, with significant river and tidal flooding events also affecting the City on a frequent. Heatwaves, cold spells, droughts, and pluvial flooding have also impacted Cork City, but less frequently. Although individual events were not identified in the timeline, coastal erosion is recognised as a long term hazard for Cork City.

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

Frequency of Identified Events According to Category (1987-2022)



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 Cork City, based upon analysis of past events and workshop feedback

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

3.2.2

Exposure, Vulnerability and Impacts for Cork City

Exposure, Vulnerability and Impacts for Cork City

On the basis of identified exposures, vulnerabilities and impacts for Cork City, the impact of climate and weather-related hazards on key categories of exposure 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 Cork City 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.

Colour coding of impact ratings

- Negligible
- Minor
- Moderate
- Major
- Catastrophic

	Current Frequency	Assets	Health and Wellbeing	Environment	Social	Cultural Heritage	Financial	Reputational	Overall Impact Score
Heatwave	Common	Minor	Minor	Negligible	Minor	Negligible	Minor	Minor	**1.7**
Drought	Common	Negligible	Minor	Minor	Minor	Minor	Negligible	Minor	**1.7**
Cold Spell	Common	Moderate	Moderate	Negligible	Moderate	Minor	Moderate	Minor	**2.4**
Heavy Snowfall	Occasional	Minor	Minor	Minor	Moderate	Negligible	Minor	Minor	**2.0**
Severe Windstorm	Very Frequent	Moderate	Minor	Minor	Moderate	Minor	Moderate	Minor	**2.4**
Tidal Flood	Very Frequent	Major	Moderate	Minor	Moderate	Moderate	Major	Moderate	**3.1**
Coastal Erosion	Occasional	None	None	Negligible	None	None	None	None	**0.1**
Pluvial Flood	Frequent	Moderate	Moderate	Minor	Minor	Minor	Moderate	Moderate	**2.6**
River Flood	Frequent	Major	Moderate	Moderate	Major	Moderate	Major	Major	**3.6**

Impacts of Current Climate Risks

Heatwaves

Frequency: Common

Cork City has been exposed to heatwave events (defined as 5 consecutive days with temperatures >25°C) over the period 1987-2022 with a wide range of impacts across the city. The most notable and costly impact relates to the maintenance and repair of road surfaces, management of key recreational areas and increased use of mechanical cooling.

Exposure	Impact Description	Rating
Assets	• High temperatures have resulted in damage to road surfaces (tar and chip) across the City and required dust and grit to be applied for safety.	**Minor**
Health and Wellbeing	• High temperatures have resulted in uncomfortable working conditions for staff with the potential for negative impacts on the health of vulnerable populations of the public. Irish buildings and homes are generally built to hold in heat rather than stay well ventilated and cool during high temperatures. This leads to an increased demand for mechanical cooling.	**Minor**
Environment	• High water temperatures associated with heatwave events have the potential to result in detrimental impacts on freshwater and marine environments.	**Negligible**
Social	• Heatwaves have resulted in congestion at key recreational areas with facilities (e.g., litter collection and parking) overwhelmed. During warm weather in 2021, a Cork City Councillor appealed to the public not to jump into The Lough.	**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 road maintenance and repair, management of congestion at sites and the increased use of mechanical cooling.	**Minor**
Reputational	• The reputational impacts of heatwaves are limited and localised.	**Minor**

Impacts of Current Climate Risks

Drought

Frequency: Common

Cork City has experienced drought conditions over the period as exemplified by the drought events during the Summer of 2018.

Exposure	Impact Description	Rating
Assets	Drought conditions (e.g. Summer 2018) resulted in the imposition of restrictions on water supply on a national and county basis.	**Negligible**
Health and Wellbeing	Water restrictions, particularly in combination with extreme heat, have the potential to result in dehydration, this poses a particular risk for vulnerable populations and outdoor workers.	**Minor**
Environment	High temperatures and dry conditions, have resulted in reduced river flow , impacting biodiversity and water quality.	**Minor**
Social	Water restrictions leads 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 supporting the provision of water (e.g., tankering).	**Negligible**
Reputational	The reputational impacts of drought conditions are limited and localised.	**Minor**

Impacts of Current Climate Risks

Cold Spells

Frequency: Common

Cork City has experienced significant extreme cold/cold spell events over the period 1987-2022 with significant events reported for 2010 and 2018 (the 'Beast from the East'). These events have wide ranging impacts across the City including disruption of transport routes, closure of business and damage to infrastructure.

Exposure	Impact Description	Rating
Assets	• Cold spells have resulted in road closure, transport disruption and increased maintenance and repair costs across the city. Storm Emma in 2018 led to all rail and Bus Eireann bus services being halted due to a red snow-ice warning. In 2022, Cork City Council crews worked around the clock to salt and grit main roads, transport corridors, and footpaths. • Extreme cold conditions in combination with snowfall have resulted in the widespread closure of business (incl. LA business services). • Freeze thaw action has resulted in damage to critical infrastructure (e.g., water infrastructure) and building stock. Burst water mains and pipes have resulted in loss of water supply for hundreds of homes in Cork City. In December 2022, four water mains across the city burst due to extreme cold. Similarly, in December 2010, hundreds of Cork City homes were without water due to burst water mains and pipes. In order to maintain supply Cork City issued night time restrictions in certain areas and also put standpipes in place to assist households with supply difficulties.	**Moderate**
Health and Wellbeing	• Extreme cold has resulted in treacherous conditions and increases risk for road users. In December 2022, Met Éireann w arned the public of treacherous conditions on paths and roads, caused by freezing weather. • Exposure to extreme cold has had detrimental impacts for the health and safety of outdoor workers and vulnerable populations.	**Moderate**
Environment	• Cold spells have the potential to result in negative impacts for biodiversity and habitats, resulting in a decrease of ecosystem health.	**Negligible**
Social	• Elderly and vulnerable populations are required to stay in place resulting in isolation. In December 2022, during freezing cold conditions, people w ere asked to check on their elderly and vulnerable neighbours.	**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 w ith maintenance and repair costs for local and regional roads, buildings and assets, and can be significant.	**Moderate**
Reputational	• Council response (e.g., gritting) across the city receives media attention but w ith limited reputational impact for Cork City Council.	**Minor**

Impacts of Current Climate Risks

Heavy Snowfall

Frequency: Occasional

Cork City has experienced significant heavy snowfall events over the period 1987-2022 with significant events reported for 2010 and 2018 (the 'Beast from the East'). These events have wide ranging impacts across the City including disruption of transport routes, closure of business and damage to infrastructure.

Exposure	Impact Description	Rating
Assets	• Heavy snowfall has resulted in road closures and transport disruption. Heavy snowfall in March 2018, led to the closure of Cork Airport. • Flooding post-heavy snowfall events results in the flooding of assets (e.g., roads and infrastructure).	**Minor**
Health and Wellbeing	• Extreme cold events have resulted in treacherous conditions and increased incidence of slips and falls amongst public and staff.	**Minor**
Environment	• Flooding post-heavy snowfall event results in overland flow of pollutants to habitats and ecosystems with detrimental effects.	**Minor**
Social	• Closure of roads and community infrastructure can result in significant social isolation for remote communities. During Storm Emma in 2018, all public transport services were cancelled and all public facilities and amenities (i.e. public offices, libraries, sports and leisure centres and community centres) were closed.	**Moderate**
Cultural Heritage	• Accumulations of heavy snowfall can result in damage to cultural heritage sites and event cancellation.	**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	• Disruption of transport and council response (e.g., gritting) across the city receives media attention but with limited reputational impact.	**Minor**

Impacts of Current Climate Risks

Severe Windstorms

Frequency: Very frequent

Cork City has been frequently exposed to wind storms over the period 1987-2022, notable examples being Storms Ophelia, Ali, Barra, and Franklin. Impacts have been experienced across the city and relate to disruption of transport, electricity, and communication networks. Severe windstorms also result in a range of environmental impacts.

Exposure	Impact Description	Rating
Assets	• Windstorm damage to power and communication transmission infrastructure (e.g., tree fall on overhead lines) has resulted in disruption of communications and energy supply. In December 2021, high winds of Storm Barra resulted in loss of power across Cork City. • Windstorms have caused disruption of transport routes as a result of treefall. Fallen trees due to Storm Diana in November 2018 impacted accessibility on the Cloghroe to Ballincollig Rd. (near Muskerry Golf Club) and on the R579 at Leemount Cross. • All Port of Cork shipping movements were suspended during Storm Ophelia. Storm Diana in November 2018, led to the cancellation of a number of flights to and from Cork Airport.	**Moderate**
Health and Wellbeing	• Windstorms posed a health and safety risk with potential for injury. Part of a roof canopy in Kent Station collapsed during high force winds in 2013. • Windstorms can restrict health services. Storm Barra in December 2021 led to all outpatient appointments and elective procedures in Cork University Hospital and Mercy University Hospital being cancelled or rescheduled.	**Minor**
Environment	• Windstorms have resulted in loss of trees and this is particularly the case for vulnerable tree species. Tree falls were reported during Storm Ali and Storm Callum in Cork City.	**Minor**
Social	• Severe windstorms and disruption of transport and communication networks has resulted in isolation of communities. Bus Éireann cancelled a number of its services in Cork City due to Storm Eunice in 2022. • Severe windstorms has resulted in the postponement of recreational activities. During Storm Ophelia in October 2017, the roof of a stand at the Turners Cross football ground was blown off, resulting in the postponement of a Cork City league fixture.	**Moderate**
Cultural Heritage	• Severe wind storms can cause structural damage to cultural heritage sites. The Church of the Ascension was damaged due to high winds during Storm Franklin in 2022.	**Minor**
Financial	• The financial impacts of severe wind storms are associated with clean-up and repair cost.	**Moderate**
Reputational	• Reputational damage as a result of wind storms is limited and is associated with short term media reporting on council preparedness and response.	**Minor**

Impacts of Current Climate Risks

Tidal Flooding

Frequency: Very frequent

Cork City is exposed to coastal storms resulting in tidal flooding and inundation of buildings and transport infrastructure. A number of areas of Cork City are subject to frequent and recurring flooding

Exposure	Impact Description	Rating
Assets	• Tidal flooding result in transport disruption and road closures on a frequent basis. Areas of cork city regularly exposed to tidal flooding include Fr. Matthew's Quay, South Mall, the Lower Glanmire Rd., Morrison's Quay, Union Quay, Lavitts Quay, and Wandsford Quay. • Tidal flooding can result in direct damage to building stock and other assets. In October 2020, approximately 100 buildings were damaged due to tidal flooding in Cork City, with many streets under up to a metre of water.	**Major**
Health and Wellbeing	• Tidal flooding poses risks to health and well being of the public and staff working in exposed areas.	**Moderate**
Environment	• Overland flow or pollutants into water courses and environmental sensitive has detrimental environmental effects.	**Minor**
Social	• Closure of transport routes due to tidal flooding results in inconvenience to communities. • Tidal flooding has also had significant financial implication for residents in the City. In October 2020, approximately 25 to 30 parked cars on Morrison's Island, Fr. Matthew Quay, and South Mall had been damaged due to floods.	**Moderate**
Cultural Heritage	• Tidal flooding can cause structural damage to cultural heritage sites. The Quay's of Cork City form an important part of the City's built heritage and have suffered damages as a result of significant tidal flooding events.	**Moderate**
Financial	• Financial implications associated with tidal flooding relate to increased costs associated with emergency response (e.g. pumping), clean-up and repair). The OPW estimated that damages caused by the 2014 tidal floods amounted to €40 million.	**Major**
Reputational	• For those areas subject to frequent inundations, there is a the potential for reputational damage to the Council due to a public perception of limited response.	**Moderate**

Impacts of Current Climate Risks

Coastal Erosion

Frequency: Occasional

Exposure	Impact Description	Rating
Assets	• None	None
Health and Wellbeing	• None	None
Environment	• Coastal erosion has the potential to result in damage to coastal habitats in the city, e.g. Cork Harbour Ramsar Site	**Minor**
Social	• None	None
Cultural Heritage	• None	None
Financial	• None	None
Reputational	• None	None

Impacts of Current Climate Risks

Pluvial (rain) flooding

Frequency: Frequent

While pluvial flooding occurs less frequently in the City, its impacts are still considerable.

Exposure	Impact Description	Rating
Assets	• Pluvial flooding has resulted in the temporary inundation of assets. Flooding in June 2012 led to extensive damage to the Douglas Shopping Centre. The flooding was caused by a blockage of a culvert trash screen which impeded drainage. • Pluvial flooding results in damage to road surfaces and disruption to transport networks. Extreme rainfall in October 2022, caused widespread flooding and led to flooded roads across the city, roads affected included the South City Link Rd., Monaghan/ Centre Park Roads, and Blackpool.	Moderate
Health and Wellbeing	• Heavy precipitation and floodwater leads to dangerous driving conditions for both council staff and public. • Heavy rainfall can disrupt provision of healthcare services. • The Christ King Secondary School could not operate at full capacity due to issues with its wastewater system following floods.	Moderate
Environment	• Pluvial flooding has resulted in the overland flow of pollutants (nutrients, sediment and pesticides) with impacts on terrestrial and freshwater ecosystems.	Moderate
Social	• Road closures can result in inconvenience for local communities and the closure of public and recreational facilities. The Glanmire Library was closed for a number of days in October 2022 due to flood damage.	Minor
Cultural Heritage	• Pluvial flooding puts built heritage with stone cavities at risk of soakage and leakage.	Minor
Financial	• The financial implications of emergency response (e.g. pumping and emergency co-ordination, clean-up and repair) can be significant. • Increased budget pressure to adapt to impact of climate change, e.g. flood protection measures and upgrading of existing drainage systems.	Minor
Reputational	• Pluvial flooding issues are localised but can result in reputational damage to the council..	Moderate

Impacts of Current Climate Risks

Fluvial (river) flooding

Frequency: Frequent

Cork City is highly exposed to fluvial (river) flooding, with flooding experienced on a very frequent basis. Fluvial flooding is exacerbated when combined with a tidal surge event resulting in extensive flooding across the city centre.

Exposure	Impact Description	Rating
Assets	• River flooding has resulted in the temporary inundation of buildings. Flooding in 2009, submerged 30 of UCC's 80 acres in flood water, affecting 27,000m2 of its building stock. Householders of Meadowbrook in Glanmire, experienced flooding in 2012 and 2015, with some homes under 5ft of water. • River flooding results in transport disruption and road closures. In December 2015, there was flooding on the Carrigrohane Straight, at the Kinsale Road Roundabout, and on the Passage and Rochestown roads on the south side of the city. • River flooding and fast flowing rivers can cause damage to bridges through hydrodynamic scour.	Major
Health and Wellbeing	• Heavy precipitation and floodwater leads to dangerous driving conditions for both council staff and public. • Fluvial floods in 2009, put the lives of the Cork City population at risk, patients in parts of the Mercy University Hospital were evacuated to higher floors as a precautionary measure. Similarly, approximately 2,000 UCC students were forced to evacuate their student residences.	Moderate
Environment	• River flooding can result in the overland flow of pollutants (nutrients, sediment and pesticides) with impacts on terrestrial and freshwater ecosystems. Heavy downpours in February 2021, waterlogged land, weakened tree foundations, also resulted in increased surface run-off into rivers.	Moderate
Social	• Road closures can result in significant inconvenience for communities. In February 2021, the River Lee burst its banks at the Lee Fields, resulting in the closure of the Carrigrohane Rd, a section of the Lee road, the Cloghroe Rd, and the Inniscarra Rd. • The Mardyke Arena, a sports complex that caters for approx. 20,000 users per year, closed for a period of 3 months following extensive flooding in November 2009. • Inhibited development of communities as a result of frequent river flooding.	Major
Cultural Heritage	• The historic city quay walls are at risk due to fluvial flooding. In August 2022, a section of wall along the quay by South Gate Bridge collapsed.	Moderate
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. Emergency services responded to flash floods in the Douglas village area of Cork City in October 2019. • Damages caused by the 2009 river floods were estimated to amount to €90 million by the OPW.	Major
Reputational	• Due to the city's high level of exposure to fluvial flooding, public perception of a lack of response has significant reputational damage.	Major

3.2.3

Impact Assessment (Service Delivery)

Summary of Service Level Impacts

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

On the basis of reported information and in consultation with Cork City Council, an assessment of the impacts of identified climate change hazards and impacts on the delivery of services by Cork City 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 by Cork City Council as a result of the climate hazards and impacts identified within the climate hazard profile.

The following pages provide the detailed information that informed this assessment.

	Heatwave	Drought	Cold Spell	Heavy Snowfall	Severe Windstorm	Tidal Flood	Coastal Erosion	Pluvial Flood	River Flood
Business Services	Minor	None	Moderate	Moderate	Moderate	Minor	None	Minor	Minor
Roads, footpaths, bridges: construction and maintenance	Minor	None	Moderate	Moderate	Moderate	Moderate	None	Moderate	Moderate
Building Stock	Minor	None	Moderate	Minor	Moderate	Moderate	None	Moderate	Moderate
Community Infrastructure	Minor	None	Moderate	Minor	Moderate	Moderate	None	Moderate	Moderate
Cultural Heritage	Minor	Minor	Minor	Minor	Moderate	Moderate	None	Moderate	Moderate
Stormwater / Sewerage	Minor	Minor	Moderate	Moderate	None	Minor	None	Moderate	Minor
Wastewater	Minor	Minor	Moderate	Moderate	Moderate	Minor	None	Minor	Minor
Water Supply	Moderate	Moderate	Moderate	Moderate	Moderate	Minor	None	Minor	Major
Water Quality	Moderate	Minor	Minor	Moderate	Minor	None	None	Minor	Major
Biodiversity	Minor	Major	Minor	Minor	Moderate	None	None	Minor	Minor
Community Development	Minor	Minor	Minor	Moderate	Moderate	Minor	None	Moderate	Moderate
Emergency Response	Minor	Minor	Moderate	Moderate	Moderate	Moderate	None	Minor	Major

Service Level Impacts

Heatwaves

Frequency: Common

Heatwaves result in a range of impacts for service provision by Cork City Council. The primary impacts relate to increased maintenance and repair requirements for road surfaces. 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.

Exposure	Impact Description	Rating
Business Services	• Increased staff and customer discomfort as a result of high indoor temperatures with potential for decreased productivity.	**Minor**
Roads, footpaths, bridges, construction and maintenance	• Increased health and safety risk for outdoor staff members. • Increase costs associated with repair of road surfaces across the local areas.	**Minor**
Building Stock	• Increased requirement for cooling in council offices/buildings.	**Minor**
Community Infrastructure	• Increased requirement for waste collection and traffic management at key recreational sites.	**Minor**
Cultural Heritage	• Localised degradation of cultural heritage sites due to drying out. • Increased requirements for monitoring and maintenance of cultural heritage sites.	**Minor**
Stormwater / Sewerage	• Localised damage to stormwater systems with increased requirement for maintenance and repair.	**Minor**
Wastewater	• Increased temperatures and water supply affects operations of wastewater treatment plants.	**Minor**
Water Supply	• Increased demand for water to cool infrastructure and communities. • Implementation of water conservation measures (e.g., hosepipe bans).	**Moderate**
Water Quality	• Reduced water flows impacting on water quality with increased requirement for monitoring and remediation.	**Moderate**
Biodiversity	• Increased requirement for monitoring and remediation of priority sites and potential inability to meet conservation objectives.	**Minor**
Community Development	• Increased requirement for management at congested sites.	**Minor**
Emergency Response	• Increase in number of call out to bathing areas at a localised level across the city.	**Minor**
Crosscutting	• Health and Safety of Staff	

Service Level Impacts

Drought

Frequency: Common

Drought results in a range of impacts for service provision by Cork City Council. Responding to water supply issues as a result of drought conditions puts increased pressure on LA staff. Drought puts additional pressure on community infrastructure.

Exposure	Impact Description	Rating
Business Services	• None	None
Roads, footpaths, bridges, construction and maintenance	• None	None
Building Stock	• None	None
Community Infrastructure	• None	None
Cultural Heritage	• Localised degradation of cultural heritage sites due to drying out. • Increased requirements for monitoring and maintenance of cultural heritage sites.	**Minor**
Stormwater / Sewerage	• Localised damage to stormwater systems with increased requirement for maintenance and repair.	**Minor**
Wastewater	• Increased temperatures and water supply affects operations of wastewater treatment plants.	**Minor**
Water Supply	• Increased requirement to support provision of water to communities suffering loss of water supply (e.g., Tankering).	**Moderate**
Water Quality	• Reduced water flows impacting on water quality in local areas with increased requirement for monitoring and remediation.	**Minor**
Biodiversity	• Potential for loss of priority species and habitats necessitating increased monitoring and remediation.	**Major**
Community Development	• Closure of community facilities due to water supply restrictions.	**Minor**
Emergency Response	• Increase in number of call-outs to vulnerable populations at a localised level.	**Minor**
Crosscutting	• None	None

Service Level Impacts

Cold Spells

Frequency: Common

Cold spells are considered to have the highest level of impact for the provision of services by Cork City Council. Impacts are related primarily to damage to assets and infrastructure, closure of local authority offices and services and increased demand on emergency response.

Exposure	Impact Description	Rating
Business Services	• Increased health and safety risks for public and staff.	**Moderate**
Roads, footpaths, bridges, construction and maintenance	• Increased costs associated with gritting and salting roads across the city. • Increased repair and maintenance costs.	**Moderate**
Building Stock	• Increased energy costs for buildings city wide. • Increased health and safety risks for public and staff city wide.	**Moderate**
Community Infrastructure	• Increased energy costs in community buildings across the city. • Increased health and safety risks for public and staff working in community buildings.	**Moderate**
Cultural Heritage	• Increased energy costs for cultural heritage sites. • Increased health and safety risks for public and staff at community heritage sites at a localised level.	**Minor**
Stormwater / Sewerage	• Reduced capacity for drainage resulting in standing water due to post cold spell events resulting in increased clearance cost. • Damage to stormwater infrastructure with increased requirement for maintenance and repair across the city.	**Moderate**
Wastewater	• Overland flows of pollutants due to post freezing events, causing contamination of water supplies necessitating increased monitoring and remediation. • Damage to wastewater infrastructure with increased requirement for maintenance and repair.	**Moderate**
Water Supply	• City wide water supply issues due damaged water supply infrastructure (e.g., burst pipes) resulting in maintenance and increased repair costs.	**Moderate**
Water Quality	• Reduction and disruption of water supplies across the city due to decreased water quality necessitating increased requirement on council to supply water to affected communities.	**Minor**
Biodiversity	• Prolonged cold spells impacting species at a localised level not protected from the frigid temperatures, resulting in increased monitoring and remediation.	**Minor**
Community Development	• Increased instances of localised community isolation.	**Minor**
Emergency Response	• Increased pressure on emergency response units across the city.	**Moderate**
Crosscutting	• Redeployment of staff	

Service Level Impacts

Heavy Snowfall

Frequency: Occasional

Heavy Snowfall is considered to have the highest level of impact for the provision of services by Cork City Council. Impacts are related primarily to damage to assets and infrastructure, closure of local authority offices and services and increased demand on emergency response.

Exposure	Impact Description	Rating
Business Services	• Closure of local authority offices and services. • Increased health and safety risks for public and staff.	**Moderate**
Roads, footpaths, bridges, construction and maintenance	• Increased costs associated with gritting and salting roads and footpaths around the city.	**Moderate**
Building Stock	• Increased energy costs for buildings. • Increased health and safety risks for public and staff.	**Minor**
Community Infrastructure	• Increased health and safety risks for public and staff. • Increased energy costs in community buildings at localised level.	**Minor**
Cultural Heritage	• Increased health and safety risks for public and staff.	**Minor**
Stormwater / Sewerage	• Reduced capacity for drainage resulting in standing water due to post cold spell events resulting in increased clearance cost. • Damage to stormwater infrastructure with increased requirement for maintenance and repair across the city.	**Moderate**
Wastewater	• Overland flows of pollutants due to post freezing events, causing contamination of water supplies necessitating increased monitoring and remediation. • Damage to wastewater infrastructure with increased requirement for maintenance and repair.	**Moderate**
Water Supply	• City wide water supply issues due damaged water supply infrastructure (e.g., burst pipes) resulting in increased maintenance and repair costs.	**Moderate**
Water Quality	• Reduction and disruption of water supplies across the city due to decreased water quality necessitating increased requirement on council to supply water to affected communities.	**Moderate**
Biodiversity	• Heavy Snowfall impacting species at a localised level not protected from the frigid temperatures, resulting in increased monitoring and remediation.	**Minor**
Community Development	• Increased instances of community isolation city wide.	**Moderate**
Emergency Response	• Increased pressure on emergency response units across the city. • Increase in response times due to heavy snowfall on roads around the city.	**Moderate**
Crosscutting	• Redeployment of staff	

Service Level Impacts

Severe Windstorm

Frequency: Very frequent

Severe windstorms can result in the closure and/or disruption of Cork City 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.

Exposure	Impact Description	Rating
Business Services	• Closure of local authority offices and services. • Increased health and safety risks for public and staff.	**Moderate**
Roads, footpaths, bridges, construction and maintenance	• City wide transport disruption and road closures affecting the wider community and local authority operations.Increased clean-up and repair costs after an event.	**Moderate**
Building Stock	• Closure of buildings and disruption of services as a result of direct damage to buildings and disruption of power resulting in increased repair costs.	**Moderate**
Community Infrastructure	• Disruption to delivery of community services across the city. • Increased clean-up and repair costs after an event.	**Moderate**
Cultural Heritage	• Increased maintenance and repair costs due to storm damage to cultural heritage sites.	**Moderate**
Stormwater / Sewerage	• None	**None**
Wastewater	• Increased drain maintenance costs for wastewater infrastructure across the city.	**Moderate**
Water Supply	• City wide water supply issues due to damaged water supply infrastructure.	**Moderate**
Water Quality	• Adverse weather conditions cause disruptions to water quality monitoring at a localised level..	**Minor**
Biodiversity	• High winds result in damage to habitats across the city. • Increased cost to protect habitats from wind damage.	**Moderate**
Community Development	• Increased power outages and damages to infrastructure result in an impact on community economies across the city.	**Moderate**
Emergency Response	• City wide increased pressure on emergency services. • Increase in response times due to heavy snowfall on roads around the city.	**Moderate**
Crosscutting	• Staff redeployment	

Service Level Impacts

Tidal Flooding

Frequency: Very Frequent

Tidal flooding have resulted in a wide range of impacts for Cork City 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. Cork City is exposed to coastal storms resulting in inundation of buildings and transport infrastructure.

Exposure	Impact Description	Rating
Business Services	• Closure of local authority offices and services. • Increased health and safety risks for public and staff.	**Minor**
Roads, footpaths, bridges, construction and maintenance	• Increased health and safety risks for public and staff. • Increased clean-up and repair costs.	**Moderate**
Building Stock	• Closure of buildings and disruption of services due to damages during flood and resulting in high repair costs.	**Moderate**
Community Infrastructure	• Damage to community infrastructure such as parks and refuse collection points. • Increased repair and maintenance costs.	**Moderate**
Cultural Heritage	• Increased maintenance and repair costs.	**Moderate**
Stormwater / Sewerage	• Localised damage to stormwater systems with increased requirement for maintenance and repair.	**Minor**
Wastewater	• Damage to wastewater infrastructure with increased requirement for maintenance and repair.	**Minor**
Water Supply	• Damage to critical water supply infrastructure with increased requirement for maintenance and repair.	**Minor**
Water Quality	• None	**None**
Biodiversity	• None	**None**
Community Development	• Inhibited development of communities at risk of tidal flooding.	**Minor**
Emergency Response	• Increased pressure on emergency response units across the city.	**Moderate**
Crosscutting	• Staff redeployment	

Service Level Impacts

Pluvial (rain) flooding

Frequency: Frequent

Pluvial (rain) flooding has resulted in a wide rang of impacts for Cork City 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.

Exposure	Impact Description	Rating
Business Services	• Localised disruption and closure of local authority services.	**Minor**
Roads, footpaths, bridges, construction and maintenance	• Widespread transport disruption and road closures. • Increased clean-up and repair costs after an event.	**Moderate**
Building Stock	• Increased maintenance and repair costs.Increased requirement for flood defence measures.	**Moderate**
Community Infrastructure	• Closure of community infrastructure and services city wide. • Increased repair and maintenance costs.	**Moderate**
Cultural Heritage	• Damage to heritage sites due to pluvial flooding requiring repair work. • Increased maintenance and repair costs.	**Moderate**
Stormwater / Sewerage	• Reduced capacity for drainage resulting in standing water. • Damage to stormwater infrastructure at a city wide level. • Increased maintenance and repair costs.	**Moderate**
Wastewater	• Damage to wastewater treatment plants. • Increased maintenance and repair costs.	**Minor**
Water Supply	• Water supply issues at a localised level requiring supplemental water provision (e.g., tankering) resulting in increased service costs. • Increased water treatment costs.	**Minor**
Water Quality	• Deterioration of water quality due to overland flow of pollutants resulting in water supply issues and environmental degradation and an increased requirement for monitoring and remediation.	**Minor**
Biodiversity	• Damage across to environmentally sensitive areas requiring monitoring and/or restoration work.	**Minor**
Community Development	• Inhibited development of communities across the city. • Damage across the city to buildings and travel disruptions impact on local economies with increased repair costs.	**Moderate**
Emergency Response	• Localised increased pressure on emergency response.	**Minor**
Crosscutting	• Staff redeployment	

3.2.3 - Impact Assessment (Service Delivery)

Service Level Impacts

Fluvial (river) flooding

Frequency: Frequent

Fluvial (river) flooding has resulted in a wide rang of impacts for Cork City 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.

Exposure	Impact Description	Rating
Business Services	• Localised disruption and closure of local authority services.	**Minor**
Roads, footpaths, bridges, construction and maintenance	• Severe transport disruption and road closures.Increased clean-up and repair costs after an event.	**Moderate**
Building Stock	• Increased maintenance and repair costs.Increased requirement for flood defence measures.	**Moderate**
Community Infrastructure	• Citywide closure of community infrastructure and services.Increased repair and maintenance costs.	**Moderate**
Cultural Heritage	• Damage to heritage sites due to river flooding requiring repair work. • Increased maintenance and repair costs.	**Moderate**
Stormwater / Sewerage	• Reduced capacity for drainage resulting in standing water. • Damage to stormwater infrastructure at a localised level. • Increased maintenance and repair costs.	**Minor**
Wastewater	• Damage to wastewater treatment plants. Increased maintenance and repair costs.	**Minor**
Water Supply	• Severe water supply issues, with the requirement of supplemental water provision (e.g., tankering) resulting in increased service costs.	**Major**
Water Quality	• Severe deterioration of water quality due to overland flow of pollutants resulting in water supply issues and an increased requirement for monitoring and remediation.	**Major**
Biodiversity	• Isolated and limited damage to environmentally sensitive areas requiring monitoring and/or restoration work.	**Minor**
Community Development	• Inhibited development of communities at a city wide level. • Damage across the city to buildings and travel disruptions impact on local economies across the city with increased repair costs.	**Moderate**
Emergency Response	• Increased pressure on emergency response, with services seen to be in danger of failing completely.	**Major**
Crosscutting	• Staff redeployment	

3.2.4

Current Climate Risk Matrix

3.2.4 - Current Climate Risk Matrix

Current Climate Risk Matrix

Based on reported information and in consultation with Cork City Council, a current climate risk matrix for Cork City has been developed based on the frequency of hazard occurrence and the associated level of impact. The assessment identified severe windstorms and tidal flooding as posing the highest level of risk for Cork City in the current period.

Severe windstorms and **tidal flooding** impact Cork City most frequently and are considered as having a moderate impact and major impact respectively. For severe windstorms, impacts are primarily associated with damage and disruption of power and communications infrastructure. Tidal flooding results in inundation of assets and road infrastructure across the city centre.

River (fluvial) flooding occurs less often, but with a greater overall impact on Cork City primarily due to direct and substantial damage to assets and infrastructure. River flooding is also associated with health and wellbeing impacts for affected populations.

Pluvial (rain) flooding is considered to pose a relatively high risk for Cork city and occurs on frequent basis with a moderate impact primarily associated with inundation of assets and road infrastructure.

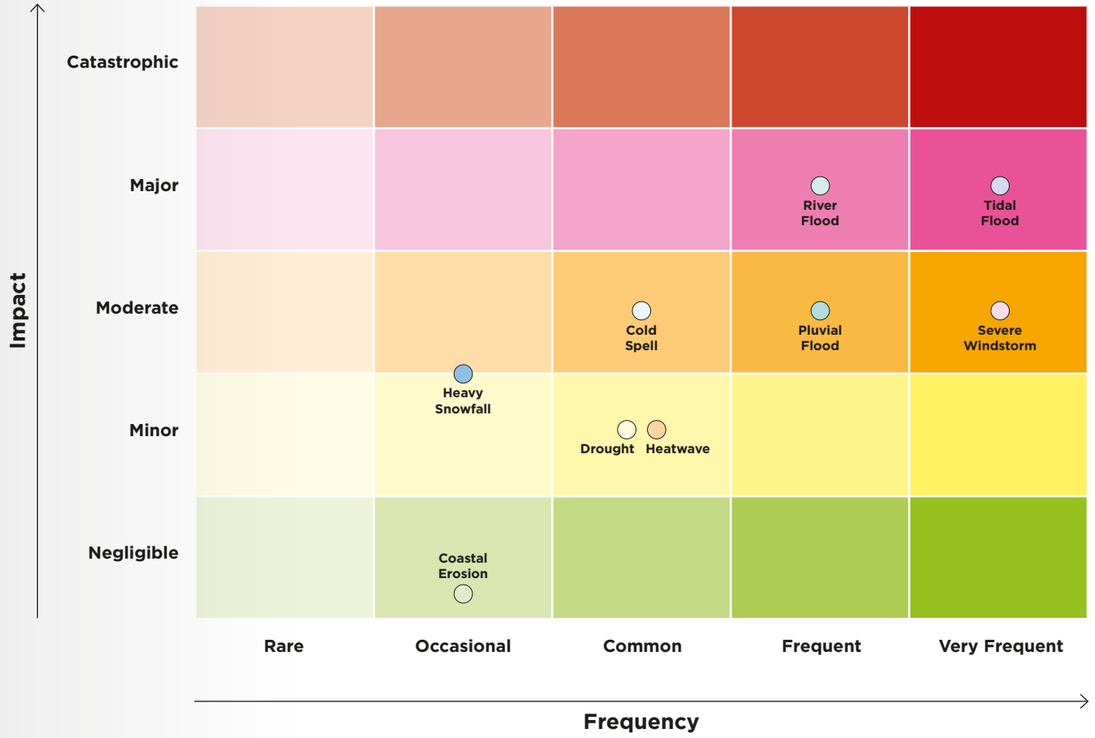
Heatwaves and Droughts are considered to occur on a common basis in Cork City; however, the overall impact is considered minor with impacts primarily associated with damage to road surfaces, disruption of water supply and environmental degradation.

Cold spells and **Heavy snowfall** events both have a moderate impact on Cork City, with impacts experienced across the city, primary impacts include damage to assets and infrastructure, increased health and safety risk for populations and potential for isolation of communities and vulnerable populations.

Impacts associated with **coastal erosion** are negligible and are primarily associated with potential impacts on Cork Harbour Ramsar site.

3.2.4 - Current Climate Risk Matrix

The risk matrix below shows the current risk for the identified hazards within Cork City



Colour coding of impact ratings

- Negligible
- Minor
- Moderate
- Major
- Catastrophic

Colour coding of climate and weather related events

- Snowfall
- Tidal Flooding
- Coastal Erosion
- Heatwave
- Cold Spell
- River Flooding
- Pluvial Flooding
- Drought/Dry Spell
- Storm
- Hurricane

3.3

Future Climate Risks and Impact

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.

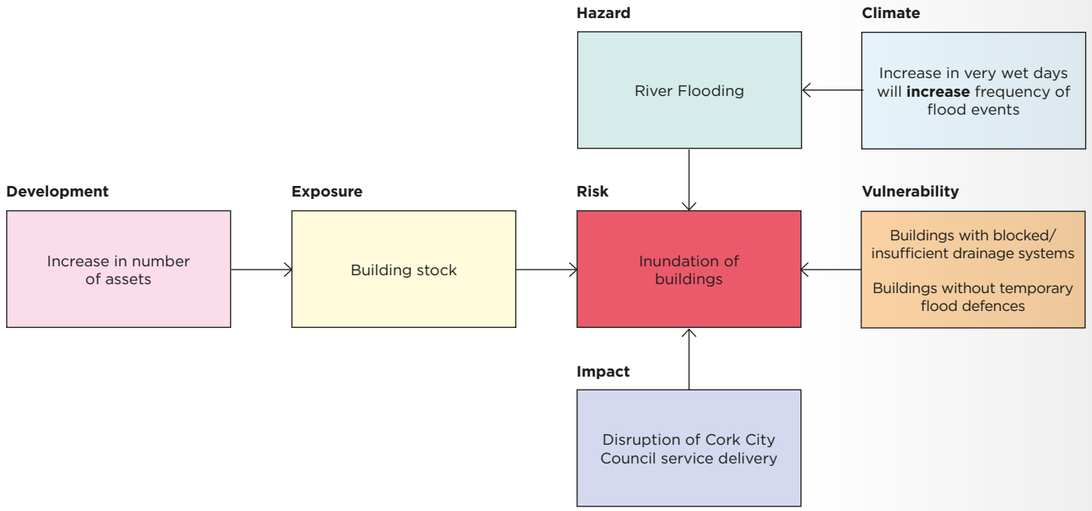
In the example below, the risk of inundation due to river flooding will increase due to an increase in the number of very wet days (> 30 mm precipitation) leading to an increase in the frequency of river flood events.

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 Cork City Council buildings will increase in the future.

In the following sections, we provide an assessment of potential future changes in the climate of Cork City by 2050 and its effects on the frequency of hazard occurrence. An assessment of the future changes in the population and development in the region by 2050 that could affect exposure and vulnerability was also undertaken.

Finally, considering all three components, the future climate risk was assessed.



3.3 - Future Climate Risk and Impact

3.3.1

Future Changes in Climate Hazards

Climate Projections for Cork City in 2050

Having identified and assessed the range of climate hazards and impacts already experienced by Cork City, 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 Cork City may change in the future.

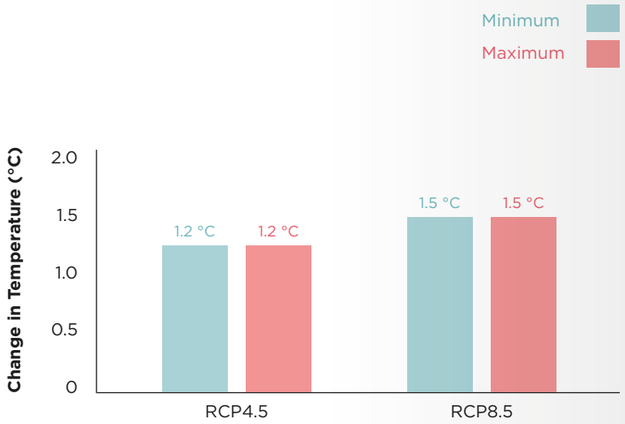
Hazard	Projected Change	Future Frequency
Heatwaves	• Projections indicate an overall increase in average temperature (graph 1) of between 1.2 and 1.5°C for Cork City relative to the 1981-2000 period. • Under a high emission scenario, projections indicate that heatwaves will become more frequent (graph 2) 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.	**Frequent** ↑
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, for both the RCP4.5 and RCP8.5 scenario.	**Occasional** ↓
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 (graph 3).	**Rare** ↓
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** –
Tidal Flood	• Projections of sea level under a high emissions scenario indicate an increase of up to 0.24 m by 2050 which will increase the frequency of coastal inundation (graph 4).	**Very Frequent** –
Coastal Erosion	• A rising sea level is strongly linked with coastal erosion and an increase in erosion rates and extent.	**Occasional** –
Pluvial and River flooding	• Projections indicate an increase in the frequency of heavy rainfall days (days with precipitation >30mm) for Cork City with some areas projected to see an increase of up to 17% (graph 5). This will likely result in an increased frequency of associated fluvial and pluvial flooding.	**Very Frequent** ↑

Source: Nolan and Flanagan, 2020

Climate Projections for Cork City in 2050

1. Mean annual temperature

The projected minimum and maximum change in the mean annual temperature for the area of Cork City 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)*

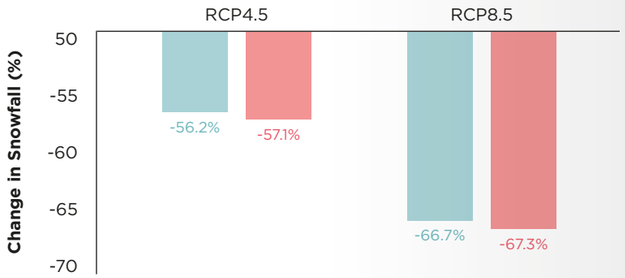


2. Number of heatwaves

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

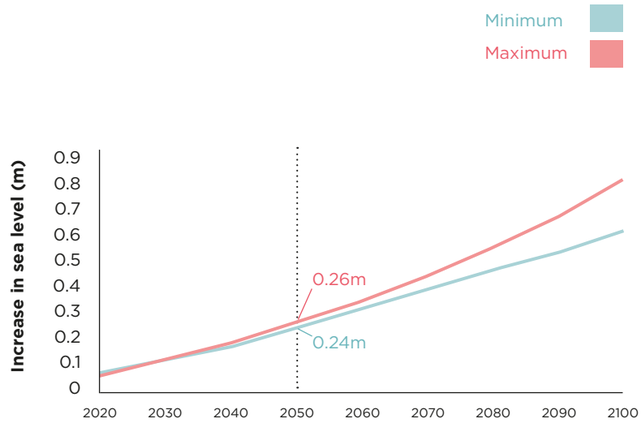
3. Change in snowfall

The projected minimum and maximum change in snowfall for the area of Cork City 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)*



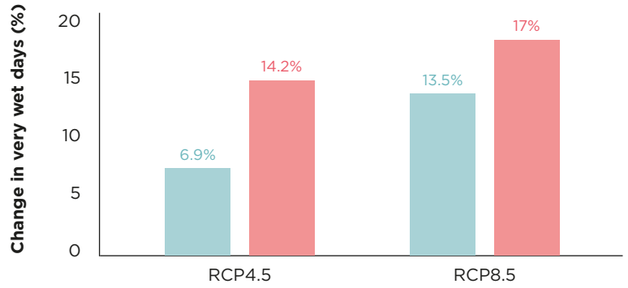
4. Increase in sea level

The projected increase in sea level for the medium (RCP4.5) and high (RCP8.5) emissions scenario offshore of Cork City (Grid Reference: 52,-9). *(Source: IPCC AR6 Sea-Level Rise Projections)*



5. Change in very wet days

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



3.3.2

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

Projected Changes in Exposure and Vulnerability

In the future, Cork City will change in terms of its population and developments. This will potentially affect the exposure and vulnerability of people and assets within the region.

National, regional and local strategies that outlined expected and possible sociodemographic and infrastructure developments within Cork City were reviewed to understand how exposure and vulnerability may change by 2050. A summary of the results of this review are shown on the following pages.

How is Ireland projected to change by 2040?

Extra 1m population

- 500,000 in rural areas
- 500,000 inregional 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

Sources:
- National Planning Framework
- Cork Joint Housing Strategy & HNDA
- Cork City Development Plan
- Cork Healthy Cities Action Plan
- SEAI
- Projects Ireland 2040 Prospects 2022

How is Cork city projected to change?

+ 30,000

Population to increase by an additional 30,000 people (12.5%) by 2028 (Cork Joint Housing Strategy & HNDA)

Aging population

With people 65+ making up 22.4% of population in 2018, higher than the national rate, 13.3% (Cork Healthy Cities Action Plan)

15,700 new housing units

c.15,700 new housing units required by 2028 (Cork Joint Housing Strategy & HNDA)

NPF National Policy Objective 3b:

"Deliver at least half (50%) of all new homes that are targeted in the five Cities and suburbs of Dublin, Cork, Limerick, Galway and Waterford, within their existing built-up footprints."

Cork CDP Objective 3.5:

"Cork City Council will seek to [...] promote compact urban growth by encouraging higher densities throughout Cork City..."

3.3.2 - Future Changes in Exposure and Vulnerability

Planning for adaptation

Flood defence schemes

Morrisons Island Flood Defence Scheme will provide flood protection for over 300 properties. The Lower Lee Flood Relief Scheme will run from Inniscarra Dam to the City Centre, protecting over 2,100 properties, including 900 homes and 1,200 businesses, against tidal and river flooding.

Key infrastructure projects include focus for council:

- BusConnects Cork
- N/M20 Cork to Limerick
- M8/N25 Dunkettle Interchange

Notable renewable energy initiatives include:

- Port of Cork has plans to develop the necessary port infrastructure to facilitate and support the offshore renewable energy and green hydrogen sectors.
- Sustainable Energy Communities (SECs) include Energy Cork, Ballyphehane and Togher Community Associations

Planning for mitigation

Case Study in Urban Planning: Cork City Docklands

146 hectares

Cork City Docklands is Ireland's largest regeneration project. Over 146 ha of land will be developed over a period of 20 years.

+20,000

The vision for Cork Docklands is to grow the heart of the City, provide homes for c.20,000 new residents and more than 25,000 jobs. Creating new sustainable neighbourhoods, in a location where all required amenities and services are easily accessible and car dependency is greatly reduced.

€600 m

€600 m+ in public sector investment is required to advance enabling infrastructure such as transport, drainage, flood protection, community, public realm and amenity.

Future Exposure and Vulnerability

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.

Assets	• Due to the expected increase in Cork City's population, there will be an **increase in the associated households and infrastructure** resulting in an increase in the number of assets exposed to hazard events • Due to the expected increase in the frequency of heatwaves, **road assets will be more regularly exposed to extreme temperatures** and **drought** conditions with the potential for increased damage to roads • Pluvial, river and tidal 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 & Wellbeing	• Due to the expected increase in the elderly population in Cork City there will be a **greater number of vulnerable people who are more sensitive to hazards**, particularly heatwaves • Pluvial, river and tidal 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 Cork City 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 and biodiversity • Due to the potential increased frequency of exposure to hazards in Cork City, there could be an **increase in the impact on environmental assets** as the time/ability for the habitat/environment to recover is reduced • Pluvial, river and tidal flooding events that were once considered extreme, will become more frequent. Consequently, environmental assets will be more frequently exposed to flooding hazards, and higher flood levels will mean **environmental assets previously unaffected by flooding may become exposed** - resulting in short and long term damage to habitats/ biodiversity by these hazards

Social	• Due to the expected increase in the total and elderly population in Cork City there will be an **increase in the number of people affected by social isolation during some hazard events** • In response to heatwaves, there will be an increased use of blue/green spaces by the public **putting increased pressure on local amenities** e.g. littering, traffic problems
Cultural Heritage	• Pluvial, river and tidal flooding events that were once considered extreme, will become more frequent. Consequently, **cultural heritage assets will be more frequently exposed to flooding hazards**, and higher flood levels will mean cultural heritage assets previously unaffected by flooding may become exposed resulting in short and long term damage to cultural heritage assets by these hazards. • Due to the potential increase in frequency of heatwave and drought events, **degradation rates will potentially increase resulting in an increase in the impact of cultural heritage assets**
Financial	• Due to the potential increase in frequency of hazard events and exposure across Cork City, 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 Cork City 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 Cork City, e.g. river flooding, if the response to the increased frequency and severity events is deemed insufficient by the public, this **may negatively impact on the reputation of the local authority**

Future Impacts

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

	Assets		Health & Wellbeing		Environment		Social	
	Current	Future (2050)	Current	Future (2050)	Current	Future (2050)	Current	Future (2050)
Heatwave	Minor	Moderate	Minor	Moderate	Negligible	Minor	Minor	Moderate
Drought	Negligible	Minor	Minor	Moderate	Minor	Moderate	Minor	Moderate
Cold Spell	Moderate	Moderate	Moderate	Moderate	Negligible	Negligible	Moderate	Moderate
Heavy Snowfall	Minor	Minor	Minor	Minor	Minor	Minor	Moderate	Moderate
Severe Windstorm	Moderate	Moderate	Minor	Minor	Minor	Minor	Moderate	Moderate
Tidal Flood	Major	Major	Moderate	Major	Minor	Moderate	Moderate	Major
Coastal Erosion	None	Negligible	None	None	Negligible	Minor	None	None
Pluvial Flood	Moderate	Major	Moderate	Major	Minor	Moderate	Minor	Moderate
River Flood	Major	Major	Moderate	Major	Moderate	Major	Major	Major

	Cultural Heritage		Financial		Reputational	
	Current	Future (2050)	Current	Future (2050)	Current	Future (2050)
Heatwave	Negligible	Minor	Minor	Moderate	Minor	Moderate
Drought	Minor	Moderate	Negligible	Minor	Minor	Moderate
Cold Spell	Minor	Minor	Moderate	Moderate	Minor	Minor
Heavy Snowfall	Negligible	Negligible	Minor	Minor	Minor	Minor
Severe Windstorm	Minor	Minor	Moderate	Moderate	Minor	Minor
Tidal Flood	Moderate	Major	Major	Major	Moderate	Major
Coastal Erosion	None	None	None	Negligible	None	None
Pluvial Flood	Minor	Moderate	Moderate	Major	Moderate	Major
River Flood	Moderate	Major	Major	Major	Major	Major

3.3.3

Future Climate Risk Matrix

Future Climate Risk Matrix

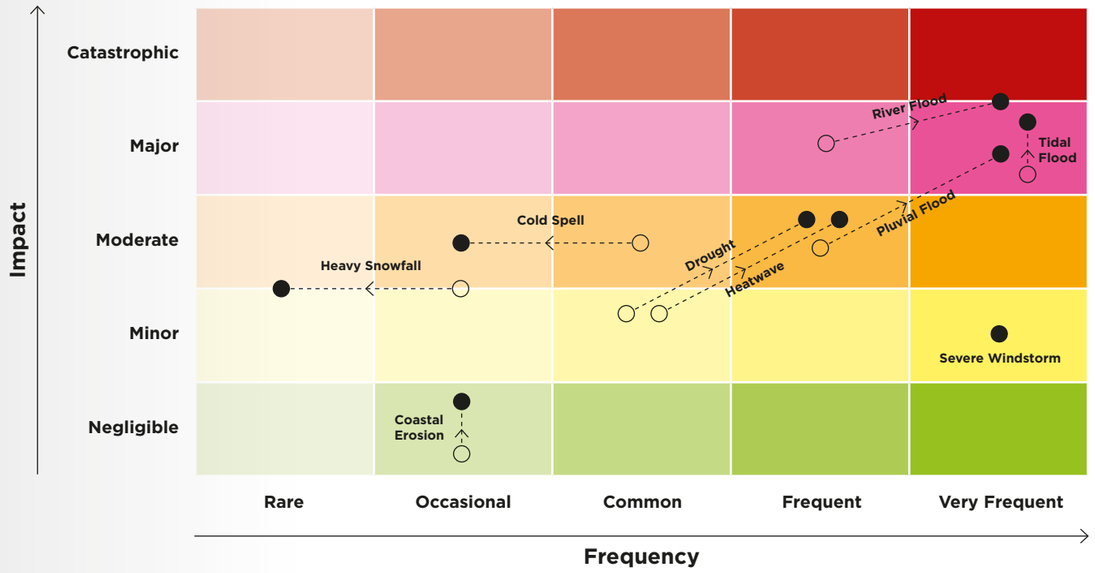
Projected changes in levels of hazard, exposure, and vulnerability, combine to form an assessment of future climate risks for Cork City.

The **risks** associated with existing hazards such as **river, pluvial, and tidal flooding** are projected to **increase** in the future as a result of projected increases in the frequency of hazard events and also due to an increase in the areas, assets and populations exposed to these hazards.

Heatwaves and droughts although already experienced in Cork City, are expected to occur more frequently and with a greater impact on Cork City in the future. The impact is exacerbated by not only projected changes in frequency of occurrence of heatwaves 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 Cork City.

The impact of **heavy snowfall and cold spells** on Cork City remains constant, however, due to projected decreases in hazard frequency, the overall risk of these hazards is likely to reduce in the future, resulting in a decreased level of risk.



The risk matrix above shows the current and future level of risk associated with climate hazards for Cork City.

- ○ *hollow marker shows the current level of risk*
- ● *solid marker the future level of risk.*
- --- *dotted line shows the change between the current and future risk.*

3.3.4

Uncertainty Assessment

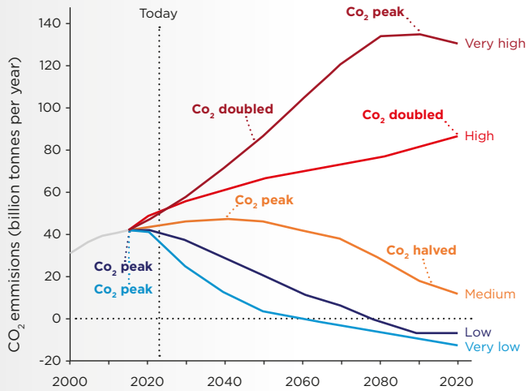
Uncertainty

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

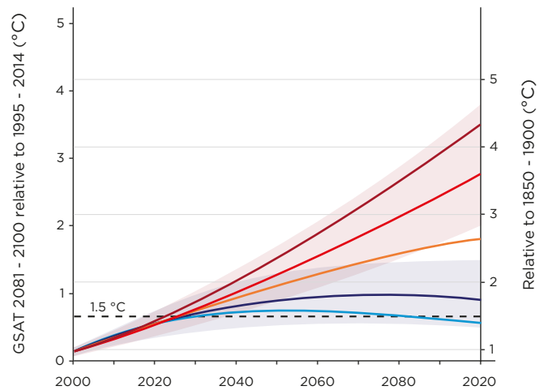
Different social and economic developments can lead to substantially different future emissions of carbon dioxide and other greenhouse gases (bottom left) resulting in uncertainty in what the future global climate will be. As an example of the possible future ranges in mean global surface temperature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

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

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



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



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

SSP1-1.9 SSP1-2.6 SSP2-4.5 SSP3-7.0 SSP5-8.5

3.4

Summary

Summary

This CCRA detailed within this report provides an assessment of the risks posed by climate change for Cork City and the implications of these risks for Cork City Council. The CCRA has been developed to support Cork City 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:

Tidal Flooding and Coastal Erosion ↑

Recent experiences of tidal flooding in 2020, and 2021, resulted in the closure / submergence of transport routes, damage to automobiles (e.g. Morrison's Island), inundation of buildings, and increased costs associated with emergency response. Rising sea levels will increase the frequency of tidal inundation, resulting in an increased flood risk for Cork City. Coastal Erosion is currently experienced in Cork City on an occasional frequency, with a negligible impact. Projections Bus Connects indicate a small increase in the impact of coastal erosion, with potential damage to coastal habitats in the city (e.g. Cork Harbour Ramsar Site).

Severe Windstorms –

Severe windstorms are currently experienced on a very frequent basis in Cork City and result in wide-ranging impacts, including damage to buildings and infrastructure (e.g. Kent Station), disruption to energy supply, and disruption of transport networks. Projections indicate no significant change to this frequency.

Heatwaves and Droughts ↑

Cork City experienced both a heatwave and a drought in 2018, with heatwaves also recorded in 2022. These events placed an increased demand on water resources, and also put increased pressure on recreational areas (e.g. the Lough). Projected increases in the frequency of heatwaves and drought conditions will mean that events currently experienced on an infrequent basis will become more frequent.

Pluvial and fluvial flooding ↑

Pluvial and fluvial flooding are significant risks for Cork City and have resulted in the inundation of homes (e.g. Glanmire) and buildings (e.g. Douglas Shopping Centre), disruption of transport networks (e.g. South City Link Rd.), increased pressure on emergency services (e.g. evacuation of residents in 2009), and the closure of public amenities (e.g. Mardyke Arena). Projected increases in the frequency of extreme precipitation events will result in increased surface water and riverine flood risk for Cork City.

Cold Spells and Heavy Snowfalls ↓

Recent experiences of cold spells and heavy snowfall events in 2018 (e.g. Storm Emma) and 2022 demonstrated the wide range of impacts for Cork City. These included, amongst others, damage to water infrastructure and disruption of supply, cancellation of public transport, 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.

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

4

Appendices

4.1

Appendix 1

Glossary

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

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

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

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

Glossary

Groundwater flooding:
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

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

Pluvial flooding:
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.)

4.1 - Appendix 1

Glossary

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

Shared Socioeconomic Pathway (SSP):
Shared Socioeconomic Pathways are scenarios that examine how global society, demographics, and economics might change over the next century (2100).

Tidal Flooding:
Temporary inundation of coastal areas during exceptionally high tides or storm surges

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

4.2

Appendix 2

Service Area Descriptions

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

Acronyms

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

Description of the levels of impact due to disruption of Local Authority Services

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

Characterisation of the magnitude of impact across various risk areas

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

(Source: Technical Annex B: Climate Change Risk Assessment)

4.3

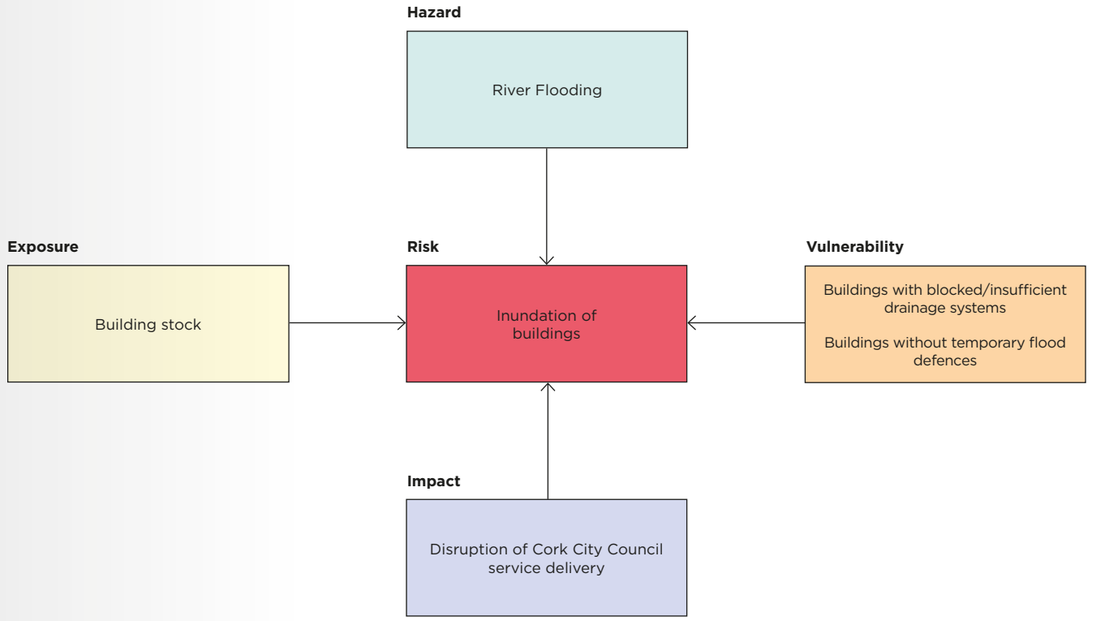
Appendix 3

Characterising Exposure, Vulnerability and Impacts of Climate Hazards

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



Exposure, Vulnerability and Impacts of Climate Hazards

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

The severe windstorm Storm Brendan in 2020 left 3,000 ESB customers without power in Cork City and many incidents of fallen trees were reported.

A cold spell of sub-zero temperatures in December 2022 resulted in numerous power outages due to freezing conditions. 431 customers affected in Mayfield and 44 customers affected in Dennehy's Cross.

During 2020 Coastal flooding, around 100 buildings and dozens of parked cars were damaged in the Cork city centre. The damages were estimated to be millions of euros.

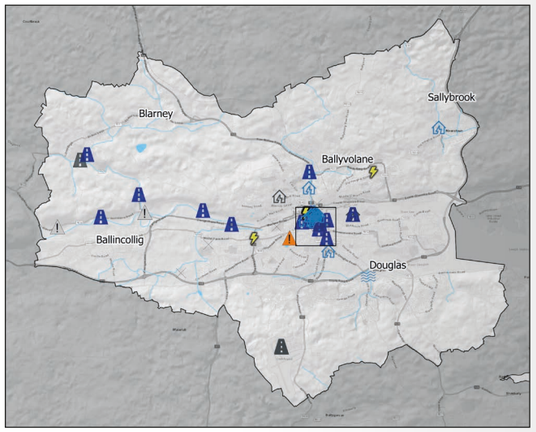
During fluvial flooding in October 2019, Douglas river burst its banks at the Church Rd side of Douglas Village Community Park in Cork City.

Storm Ellen in Aug 2020, resulted in flooding of the River Lee on Fr Mathew Quay.

In Feb 2021, the river Lee burst its banks at the Lee Fields, resulting in the closure of the Carrigrohane Rd, a key access route to the city from the west.

During Tidal flooding in Nov 2019, high tide resulted in road closure for traffic in Cork city centre in areas like Fr Mathew Quay, South Terrace and Morrison's Island.

Storm Emma resulted in power outages and flight cancellations due to heavy snowfall.



Cork City Council Local Authority Area

Rivers and Lakes

Hazards (2018-2022)

Disruption of Transport Networks/Infrastructure (flooding)

Disruption of Transport Networks/Infrastructure (wind)

ESB power outage

Event closure

Public safety/accident (heatwave)

Public safety/accident (wind)

River flooding

Structural/property damage (flooding)

Structural/property damage (wind)

Impacts of Climate Hazards 1/4

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 • Increased demand on available water resources, leading to increasing pressure to share resources • 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, outdoor workers (elderly, with limited access to water, shade and sunscreen) • River-side 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) • Reservoirs/lakes (Lakes already depleted/under stress) • Emergency response services • Recreational areas (recreational users with lack of access to water, shade, and sunscreen) • European/Irish designated sites (SPA – Cork Harbour)
Drought	• Increased demand on available water resources, leading to increasing pressure to share resources • Increased degradation rates • Reduced river flow • Damage to built heritage	• Reservoirs/lakes/groundwater supplies (lakes already depleted/under stress) • Biodiversity (areas with diverse wildlife populations) • Homes/businesses/local govt office/agricultural sites (built heritage in more exposed locations)

Impacts of Climate Hazards 2/4

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 • 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) • Transport network (road and rail) • Road network (vulnerable communities) • Public/staff (elderly populations, people with pre-existing conditions) • Water infrastructure/pipes (older pipes, in areas of freezing soil conditions) • Water resources • 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 such as Cork Harbour (SPAs, SACs, Ramsar sites, NHAs) • Built heritage (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 • Disruption to energy/electricity supply • Impact on business and local economy • Disruption to waste collection • Snow melt resulting in increased risk of flooding	• Buildings (vacant/flat roof properties, higher elevation, elderly residents), Offices (incl. LA) (single story/flat roof, higher elevation, impervious surfaces) • Transport networks (communities with limited transport options) • Energy supply (energy infrastructure in need of maintenance, older infrastructure) • Natural resources/sensitive materials/water supply (environmentally sensitive areas - terrestrial and aquatic). • Areas prone to flooding (areas with inadequate drainage)

Impacts of Climate Hazards 3/4

Hazard	Key Impacts	Key Exposures (and Key Vulnerabilities)
Severe Windstorm	• Direct wind damage to buildings and infrastructure • Unsafe working conditions for outdoor staff • Wind damage to trees (e.g. parks and along roads) • Disruption of communications infrastructure and energy supply across the city • Disruption of transport networks • Closure of parks and public buildings • Disruption to waste collection • Disruption of recreational activities • Impact on harbours and marinas • Disruption to water treatment	• Buildings, development sites (buildings w. rooftop equip., vulnerable populations, high-rise structures) • Outdoor workers (workers with limited access to shelter) • Urban tree planting (trees which are more vulnerable to wind) • Power and communications supply (energy/ communications infrastructure in need of maintenance) • Road and rail network (in exposed locations) • Parks, public buildings (in exposed locations) • Waste collection routes (routes in exposed locations) • Recreational amenities (users with lack of access to shelter/ protection from storm conditions) • Water treatment facilities (gravity fed water treatment facilities)
Tidal Flood	• Temporary inundation of buildings • Closure/submergence of transport routes and impact on commuting, accessibility and travellers • Damage/degradation to automobiles and public transport. • Damage to recreational amenities and facilities provided by the council • Damage to water treatment and wastewater infrastructure • Potential bridge failure	• Housing buildings, heritage sites (older buildings which where stone cavities are at risk of soakage and leakage) • Roads situated in low-lying areas which may be prone to high-tide flooding • Council fleets, public transport and private vehicles (carparks and parking spaces located in low-lying areas with limited permeable surface) • Recreational amenities (amenities not served by suitable drainage) • 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	• Alteration of sedimentation patterns in ports and harbours • Damage to coastal habitat	• Harbour/ Port (Ports in need of maintenance) • Coastal habitat (sites exposed to existing coastal erosion)

Impacts of Climate Hazards 4/4

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 • Quay wall collapse • 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 which lack sufficient drainage systems) • Stormwater infrastructure (areas where these is a lot of un-reinforced waste management systems containing potential debris (natural/man-made)), People (Riversides and parks- especially ones located near sources of debris) • Road/Railways (Low-lying roads with no alternative access routes and which allows for the pooling of water) • Natural resources/sensitive materials (Enviro. sensitive areas); Wastewater treatment infrastructure • Quay walls (Quays in need of investment for protection) • Employers, employees, customers, students (reliant on access to at-risk areas and without alternative options for remote work/commerce/study)
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/ Quay wall collapse • Increased pressure on emergency services • Damage to critical water infrastructure	• Buildings, local authority offices, heritage sites (blocked drainage, loc. on floodplains, vulnerable residents) • Recreational amenities (low-lying parks, located near water bodies, parks and amenities in need of investment) • Stormwater infrastructure (areas where there is a lot of un-reinforced waste management systems containing potential 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 (businesses located in low-lying areas which lack sufficient drainage and pervious surfaces) • Council fleets, public transport, private vehicles (underground/low-lying carparks, fleets sensitive to submergence) • Bridges/ Quay walls (Bridges in need of investment for scour protection to abutments and piers) • Emergency services • Critical water infrastructure

Comhairle Cathrach Chorcaí
Cork City Council