TIER 1 CLIMATE CHANGE RISK ASSESSMENT

Carlow County Council

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RPS

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Carlow County Council

Dublin | Cork | Galway | Sligo
rpsgroup.com

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1 EXECUTIVE SUMMARY

On behalf of Carlow County Council (CCC), RPS has prepared a Tier 1 Qualitative Local Authority Climate Change Risk Assessment (CCRA) to support the development of the Local Authority Climate Action Plan (LACAP) 2024-2029. In accordance with the methodology provided in Annex B of the LACAP guidelines, this report provides an assessment of the current and future climate risks and impacts on the operations and delivery of services by CCC. The assessment of these risks will raise awareness of the consequences of climate change, help to prioritise risks, and help to monitor and track changes in climate risks. This CCRA will inform the adaptation section of the new Carlow County Council Climate Action Plan which will constitute part of the National Adaptation Framework.

The review undertaken for this CCRA included collating existing regional and national level data relating to climate events, followed by a multi-party workshop with key service area stakeholders within Carlow County Council. The workshop facilitated review of historic climate events, hazards, impacts, exposures, and vulnerabilities affecting the local authority services and functions. This CCRA also builds on the previous risk assessment carried out as part of the Climate Change Adaptation Strategy[1] (CCAS) in 2019. The climate data and impacts on council services mentioned in this CAS are brought in line with the Annex B guidelines and incorporated into this CCRA.

This process resulted in the development of a climate hazard profile for County Carlow. Following an assessment of the nature and frequency of climate hazards a qualitative assessment of the overall impact based on the level of disruption to the delivery of local authority services and functions was assessed for both current and future climate events.

Based on the qualitative risk assessment, as presented in this report, the most significant current climate risks in County Carlow were identified as:

- **River Flooding;**
- **Extreme Precipitation;**
- **Drought.**

Increasing impacts are envisaged for future climate events across most climate hazards, however future projections indicate that flooding is likely to remain as the most significant.

As a Tier 1 assessment, this CCRA can be used to inform general strategies to mitigate current and future impacts, providing a broad understanding of climate change risk. To further support the effective implementation and management of adaptation action in the future, there is a need to carry out semi-quantitative (Tier 2) to quantitative (Tier 3) approaches to risk assessment, with each step providing greater level of information on which to base adaptation decisions.

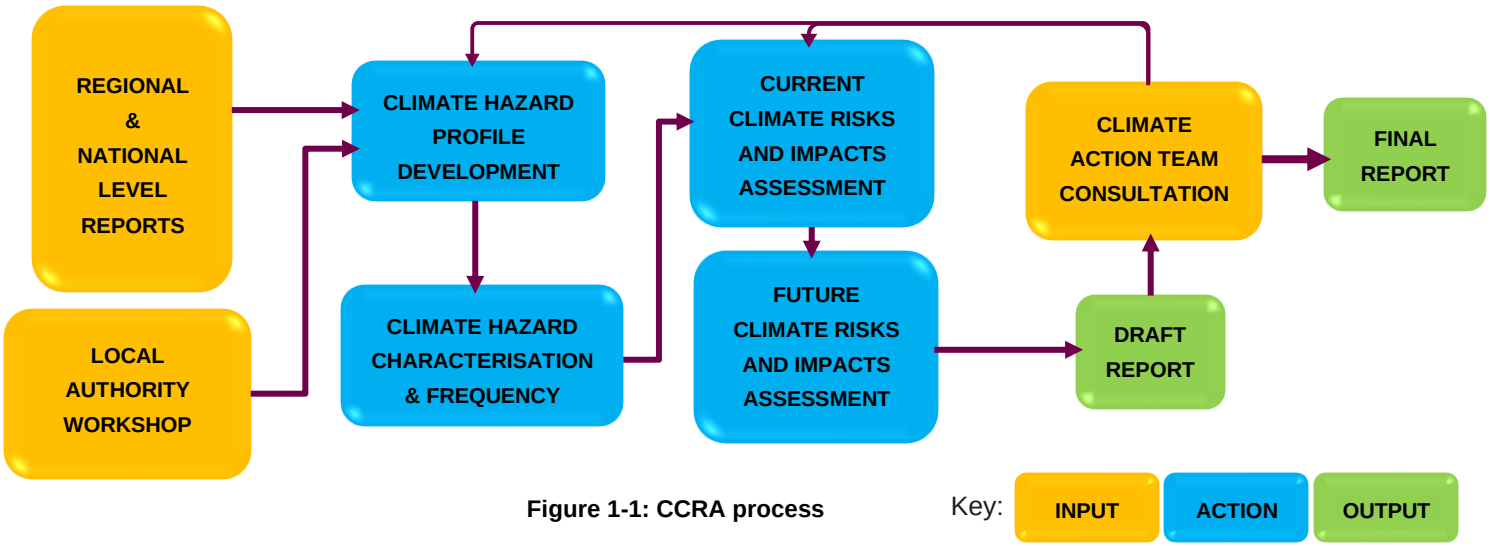


Figure 1-1: CCRA process

[1] CCC. Climate Change Adaptation Strategy 2019-2024. 2019

2 CONTEXT

The National Climate Change Adaptation Framework (NCCAF) developed in 2012 provided a strategic policy focus to ensure adaptation measures were taken across different sectors and levels of government to reduce Ireland's vulnerability to the negative impacts of climate change. The aim of the NCCAF was to ensure that an effective role was played by all stakeholders in putting in place an active and enduring adaptation policy regime. The governance structure provided for climate change adaptation to be addressed at national and local level, consistent with the approach being taken at EU level in the White Paper on Adaptation

2012
NCCAF

The first phase focused on identifying national vulnerability to climate change, based on potential impacts relative to current adaptive capacity. Reliable information on the range of socio-economic vulnerabilities, the costs and benefits, and the options available and appropriate to Ireland, were key elements to inform effective adaptation planning. A key component was to provide the evidence base necessary to inform development of the national agenda.

2015
CA & LCDA

The second phase involved the development and implementation of sectoral and local adaptation action plans to form part of the comprehensive national response to the impacts of climate change. Sectoral plans are prepared by the relevant Department or Agency and are adopted by the relevant Minister. Draft sectoral plans should be reviewed at least every 5 years.

The Climate Action and Low Carbon Development Act 2015 was a landmark national milestone in the evolution of climate change policy in Ireland. It provides the statutory basis for the national transition objective laid out in the National Policy Position. Further to this, it made provision for, and gave statutory authority to both the National Mitigation Plan (NMP), published in 2017 and the National Adaptation Framework (NAF).

2017
NMP
2018
NAF

Ireland's first statutory NAF was published by Minister Denis Naughten TD on 19 January 2018. The NAF sets out the national strategy to reduce the vulnerability of the country to the negative effects of climate change and to avail of positive impacts. The NAF was developed under the Climate Action and Low Carbon Development Act and built upon the work already carried out under the NCCAF.

The annual review of the adaptation progress in Ireland[2] gives a summary of the progress made by various sectors on the adaptive capacity, resource and mainstreaming, and governance of the implementation of climate change adaptations. The Climate Action Regional Offices (CARO) and Local Authorities are listed under the Local Government Sector, which has shown good overall progress in 2022. The key challenge remains the resourcing of dedicated staff to ensure consistency, coordination, and implementation. The realised desire noted for closer working with national agencies on risk assessments, adaptation policies and tools for use by local authorities is essential to enabling progress on adaptation by the local authorities and national agencies. This is highlighted again in the CARO progress report[3] where delays in the delivery of implementation are due to lengthy stakeholder consultation processes; capacity and capability constraints across the public sector; and desires for alignment with other measures to enhance impact.

2019
CCAS

This Climate Change Risk Assessment (CCRA) will inform the adaptation section of the new Carlow County Council Climate Action Plan which will constitute part of the NAF.

CCRAs aim to further our understanding of the risks posed from the changing climate and form an integrated part of any climate change adaptation planning process. CCRAs provide a basis for making decisions on whether risks, and what level of those risks, are acceptable to society or the community by obtaining, collating and analysing information on the projected impacts and consequences of climate change.

2023
CCRA

[2] ECOPRO Project. Climate Change Advisory Council - Annual Review 2022. 2022

[3] CARO. CARO - Progress Report 2022 Implementation of Actions for Climate Change Adaptation Strategy. 2022

3 INTRODUCTION

RPS was contracted in November 2022 to carry out a Tier 1 Qualitative Local Authority Climate Change Risk Assessment (CCRA) for Carlow County Council, as part of the development of their Local Authority Climate Action Plan LACAP, in accordance with the methodology provided in Annex B of the Local Authority Climate Action Plan Guidelines. The CCRA focuses on the delivery of services and functions by the local authority.

In line with the methodology provided within Annex B of the Guidelines, the CCRA provides for:

- Current Climate Risks and Impacts Assessment i.e. An assessment of the current climate hazards, exposure and vulnerabilities of climate change on the operations and efficient delivery of services by the local authority.
- Future Climate Risks and Impacts Assessment i.e. An assessment of future climate risks and impacts on the operations and efficient delivery of services by the local authority.

3.1 Tier 1 Assessment

Climate change risk assessments can be qualitative (Tier-1), semi-quantitative (Tier-2), or fully quantitative (Tier-3), with each tier building on the previous and requiring an increasing level of data, information, and complexity to develop[4]. This climate risk assessment uses a qualitative (Tier-1) approach.

A first-pass assessment (Tier 1) is a rapid qualitative process that can be carried out without detailed local data to develop a preliminary understanding of the climate change risks over a range of scales, from local to regional. This process helps users to screen climate-related hazards and identify specific risks that may arise from these hazards, and which should be investigated further (through second- and third-pass risk assessments). This first-pass screening is ideal when carrying out a CCRA with resource constraints, including limited data and information. It also allows integration of data and information from a variety of (qualitative and quantitative) sources. This is an important early step in climate adaptation planning. Usually, the initial first-pass risk assessment is conducted with limited project-specific data, instead using qualitative information, evidence from published literature and available data such as default national figures. The outcome of a first-pass risk assessment provides a broad understanding of the impacts of climate change in a specific context (be that a region, sector or business).

Appendix A further clarifies the different characteristics and requirements of each of the three risk assessment tiers.

3.2 Approach

Assessment of climate change risk underpins evidence-based adaptation planning and implementation. Climate change risks differ from other risks as it can be difficult or even impossible to quantify short-term or long-term probabilities. As a result, conventional risk assessments that use statistical probabilities can be ineffective.

To assess climate change, risk is composed of three inter-related components[5]:

- **Hazards:** Refers to potential source of harm in terms of damage/loss of property/infrastructure, potential injury, loss of life or other health impacts, livelihoods, service provision, ecosystems, and environmental resources. In this document, this term refers to climate-related physical events or trends or their physical impacts.
- **Exposure:** Refers to the presence of assets, infrastructure, property, people, livelihoods, species or ecosystems, environmental functions, services, resources in places or settings that could be affected. It is important to note that exposure can change over time, e.g., because of land use change.

[4] Stephen Flood et al., National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action, Report 346 (EPA Research, 2020).

[5] ISO, “Adaptation to Climate Change – Guidelines on Vulnerability, Impacts and Risk Assessment (14091),” vol. ISO 14091:, 2021.

- **Vulnerability:** Refers to the propensity or predisposition to be adversely affected. This encompasses sensitivity (which refers to the degree to which an exposure will be adversely or beneficially affect by climate hazards) and adaptive capacity which refers to ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Figure 3-1 shows the direct and indirect interconnections between the three components of climate risk and highlights the need to understand elements of both climate and socioeconomic processes to assess risk. Therefore, to understand the possible impacts of climate change, a climate change risk assessment is required. It has been acknowledged that the Sixth Assessment Report was published on the 20 March 2023, however this report refers to the Fifth IPCC Assessment Report as this was available at the date of completing the CCRA.

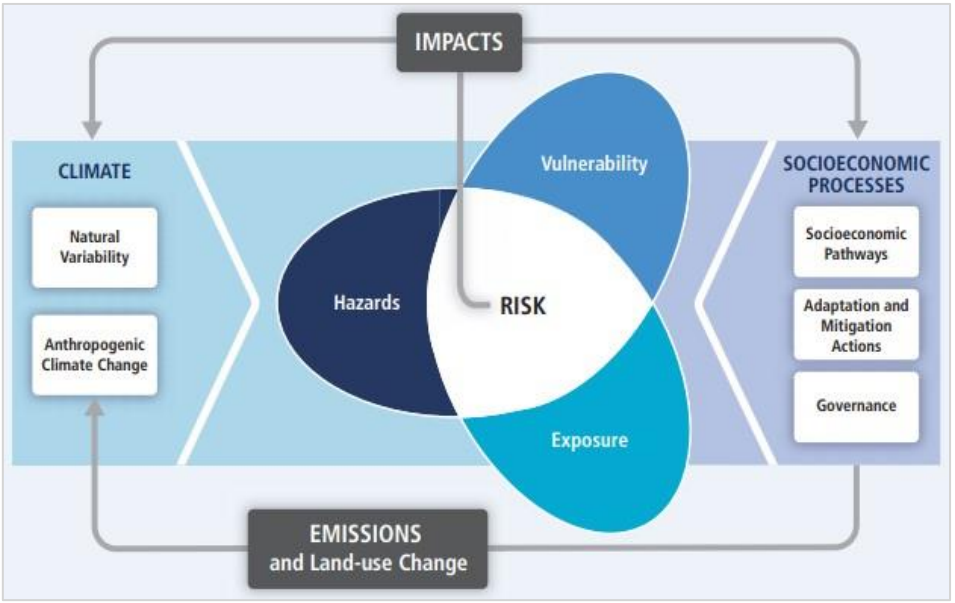


Figure 3-1: The Intergovernmental Panel on Climate Change Assessment Report 5 Framework of Climate Risk which shows how the three components of risk (hazards, exposure, vulnerability) are connected to climate and socioeconomic processes[6]

Climate risk assessments provide several benefits:

- Raising awareness: Risk assessments help increase awareness of the consequences of climate change.
- Identification and prioritisation of risks: Many factors can contribute to a climate risk, and climate change risk assessments provide insight into these factors, and this helps the organisation to prioritise the risks to be addressed.
- Identification of entry points for climate change adaptation intervention: The results and the process of risk assessment can help identify possible adaptation responses. Risk assessments can show where early action is required, e.g., to avoid locking-in future impacts and to highlight the need for development of adaptive capacity.

[6] IPCC, Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, ed. C.B. Field et al., Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2014), papers2://publication/uuid/B8BF5043-C873-4AFD-97F9-A630782E590D.

- Tracking changes in risk, and monitoring and evaluating adaptation: Repeating risk assessments can help to track changes over time and generate knowledge on the effectiveness of adaptation.

This Report provides a qualitative (Tier-1) climate change risk assessment undertaken for County Carlow and was developed based on the existing local authority adaptation strategy guidelines[7] , along with the *'Adaptation to climate change - Guidelines on vulnerability, impacts and risk assessment'* International Standard[8] , guidance on the climate proofing of infrastructure[9] , the National Risk Assessment of Impacts of Climate Change[10] , and ongoing risk assessment research.

In addition, the approach outlined within this Report builds upon the data and information produced within the previous CCC Climate Adaptation Strategy 2019-2024. **Figure 3-2** provides an overview of the key stages of developing the CCRA. An assessment of the current climate hazards, exposure, vulnerabilities, and impacts leads to the 'Current Climate Risks and Impacts'. This is followed by an assessment of future climate risks and impacts, resulting in the 'Future Climate Risks and Impacts'.

A workshop was held with multi-party input across a wide range of services areas within Carlow County Council, where historic climate events, existing hazards, exposures and vulnerabilities were discussed.

Figure 3-2: Overview of the stages of the Climate Change Risk Assessment Spreadsheet

[7] DCCAE, "Local Authority Adaptation Strategy Development Guidelines," 2018.

[8] ISO, "Adaptation to Climate Change - Guidelines on Vulnerability, Impacts and Risk Assessment (14091)."

[9] European Commission, "Technical Guidance on the Climate Proofing of Infrastructure in the Period 2021-2027," 2021.

[10] Flood et al., National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action. 2022

4 COUNTY CARLOW

The County of Carlow Is located inland within the Southeast of Ireland in the province of Leinster covering an area of approximately 897 km^2. Carlow's landscape character is categorized into 4 primary landscape character areas: Backstairs and Mt. Leinster Uplands, Central Lowlands, River Slaney-East rolling farmland and The Rossmore Range (Killeshin Hills).

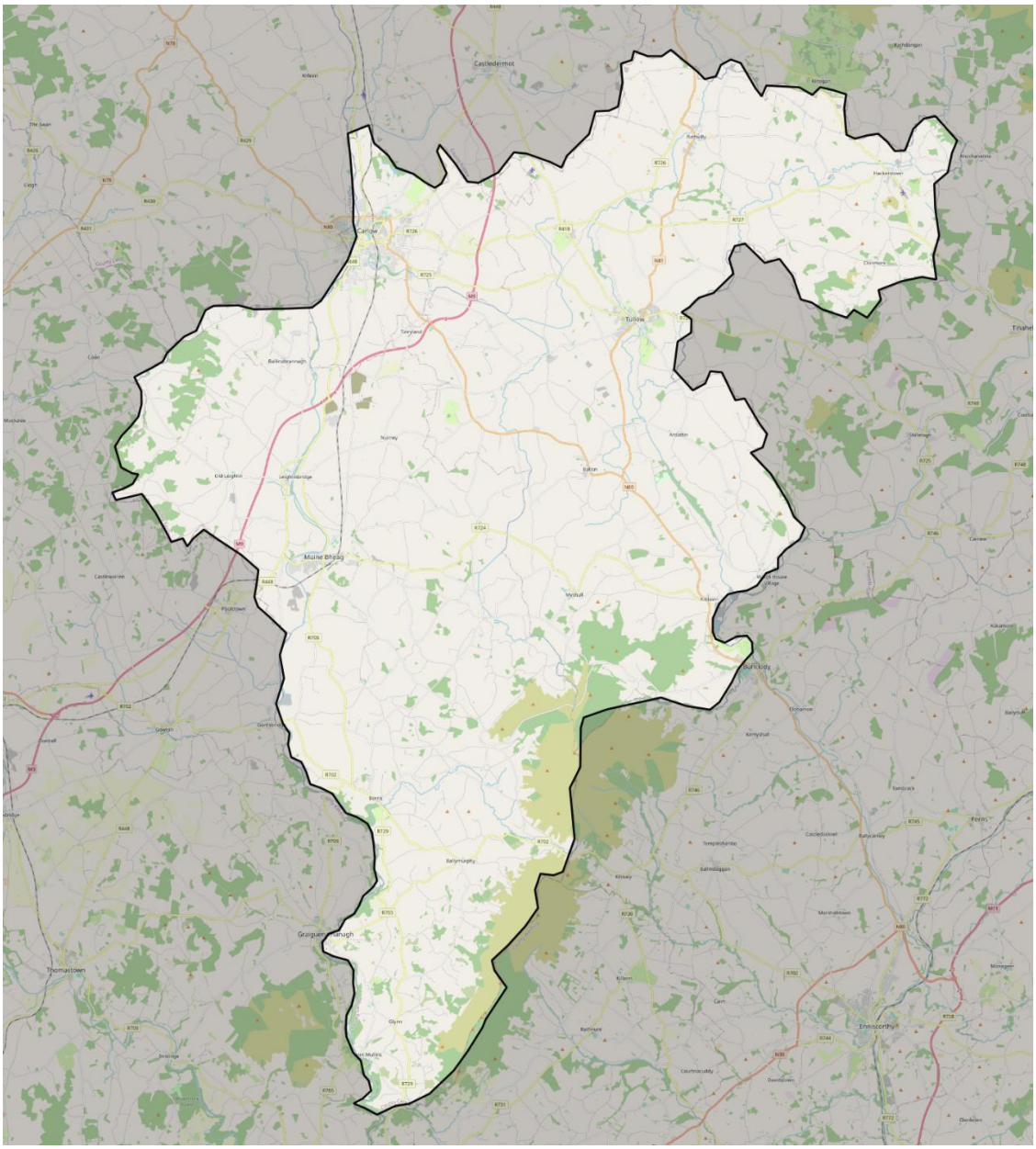


Figure 4-1: Characteristics of Carlow

The topography present within the Central Lowlands is mostly limestone towards the West and granite towards the East. Till from the lower carboniferous limestone dominates the lowlands. Material found closer to the East of the lowlands contains till from granite. Glaciofluvial sands and gravels are also present in high quantities along the River Barrow. Grey-brown podzolic soils are mostly dominated in this zone but acid brown earths are also present in the granite till areas. As a result, soils present within this area are well drained and highly suited to arable and grassland farming. The topography present within the river Slaney-East rolling Farmland Area mostly contains granite and is identified simply as rounded granite dome-shaped hills with interspersed rolling topography. Well drained brown earth and acidic soils, as well as drained gleys in partial areas make up this zones soil composition The Rossmore Range (Killeshin Hills) contains mostly

namurian shale and sandstone corresponding to the presence of the Castlecomer Plateau which is present along the north-west of the County. Poorly drained gley soils dominate the ridges of the plateau. Run-off is most pronounced at this location in addition to poor infiltration rates. Peat soils and Alluvial soils are also present within parts of the ridge. The Blackstairs and Mount Leinster uplands mostly consists of granite, sandstone and Ordovician schists. The upland areas of the Blackstairs Mountains consists of intact and cutover blanket bog whilst the lower areas consist of acid brown earths

Land area of almost **89,700 ha**

Four Landscape characters:

- Blackstairs and Mt. Leinster Uplands
- Central Lowlands
- River Slaney-East rolling farmland
- Rossmore Range

The main waterbodies present within the County of Carlow are the River Barrow, River Burren, and River Slaney. Carlow is the largest urban centre situated within the Barrow catchment and drains a total area of 3,025km². The River Barrow is the second largest river in Ireland which forms the boundary between Laois and Carlow measuring approx. 192km in length. The River Greese and River Lerr are tributaries of the River Barrow which are renowned for their plentiful fish stocks. The River Burren, another tributary of the River Barrow begins at the North side of Mt. Leinster and flows Northwards towards Rathoe where it then turns Westwards towards the N80 and enters South of Carlow town where it drains into the River Barrow. The River Slaney, measures approx. 117km in length and also passes through Carlow where it flows through Tullow town. Rivers Derry and Derreen are both tributaries of the River Slaney. The River Derry rises in Hackettstown and flows under the Clonegal bridge where it becomes a border and establishes the divergent point of Co. Carlow to the West and Co. Wexford to the East. The River Derreen rises in the Wicklow Mountains and flows Southwards passing through the towns of Hackettstown and Tullow. The Mountain and Dinin Rivers are also two prominent water bodies which flow close by to the town of Borris in Co. Carlow.

There is approximately 23km of motorway crossing through the northwest section Carlow and approximately 50km of national roads spread across the top half of Carlow. The population of Co. Carlow has witnessed significant population growth over recent years. The most recent census which took place in 2022 showed a total of 61,931 individuals living in Co. Carlow, an increase of 4,999 since the 2016 Census[11]. In the 2016 Census, approx. 19,621 individuals were under 24 years of age and approximately 7,357 individuals were over 65 years of age.

Over **73km** of roads

Main waterbodies:

- **Barrow**
- **Burren**
- **Slaney**

Population in 2016: 56,932

0 to 24 Years: 34.5%

65 and over: 12.9%

Carlow as its County town is a critical element within the settlement structure of the County. In addition to Carlow town, Graiguecullen is located on the western side of the River Barrow which forms part of a wider urban area. This urban area is known as the Greater Carlow Graiguecullen Urban Area. Both Carlow town and Graiguecullen are two areas where many individuals within Carlow reside. After Carlow town, Tullow and Muinebheag are the next major market towns in the County followed by a network of smaller towns and villages.

The infrastructure, environment, and population of County Carlow can be affected by climate hazards and are subject to greater impacts due to climate change, hence the need to assess the associated risks.

[11] www.cso.ie

5 WORKSHOP

RPS facilitated a workshop with Carlow County Council on Wednesday 23rd November 2022.

The workshop was useful for introducing the local authority teams to the CCRA process, in relation to previous risk assessment and adaptation planning, and cementing understanding and support for the CCRA.

Critical to the success of developing a CCRA is ensuring multi-party input to the process to ensure that all relevant triggers, events, and receptors are suitably captured and addressed. The workshop served as the key medium to engage with all service departments within Carlow County Council and allow for a multi-expert input to the final risk classifications. The collected notes from the workshop are provided in **Appendix B**. As noted by the guidance, the CCRA process focuses on the delivery of services and functions by the local authority.

The following Carlow County Council services were represented within the workshop:

- Carlow Municipal District
- Muinebheag Municipal District
- Roads & Transport
- Active Travel
- Environment
- Community
- Corporate Services
- Planning
- Water
- Housing
- Recreation/Amenity
- Civil Defence
- Finance
- Fire Service

The risk assessment tables, and output matrices produced within the appendices of this report were guided by national level risk assessment and further developed through both objective and anecdotal evidence brought forward by Carlow County Council at this workshop (**Appendix B**), to create a bespoke but consistent CCRA output that meets the needs at a local authority level.

6 ASSESSING CURRENT CLIMATE RISKS AND IMPACTS

Understanding current climate impacts is critical to developing an understanding of future climate risks. Assessment of the current climate impacts involved:

- Identifying the range of climate hazards that have previously affected Carlow and its administrative area, and
- Assessing the exposures and vulnerabilities of the local authority and its administrative area to these hazards.

6.1 Climate Hazards Profile

In collaboration and consultation with Carlow County Council, and with the collective input by the Eastern & Midlands CARO County Councils of Wexford, Waterford, Kilkenny, and Tipperary, a timeline of climate hazards historically affecting the local authority area have been identified and developed within this report. Climate hazards include extreme weather events and periods of climate variability, for example:

- Extreme weather events, e.g., extreme rainfall, flooding, storms, extreme heat, or drought.
- Deviations from average climatic conditions over a given time period, e.g., periods of above or below average conditions in the spatial and/or temporal distribution of precipitation, or changes in average temperature.

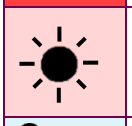
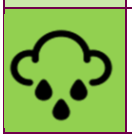
It is important to consider and identify, that many climate hazards are created or exacerbated by a pre-condition, e.g., a heavy rainfall event on saturated soils resulting in flooding. In addition, it is important to consider that the co-occurrence of multiple climate hazards can directly or indirectly exacerbate existing hazards or create new hazards, e.g., a storm causing a coastal storm surge and precipitation resulting in high river and coastal water levels resulting in fluvial and coastal flooding, or a heavy rainfall event after a period of drought creating surface water flooding.

The climate hazards profile is presented in two 15-year periods, as seen in **Figure 6-1** and **Figure 6-2**, which provides a review of the extreme weather events in County Carlow over the past 30 years. All climate hazards identified within a single event are noted within the profile. An expanded summary of each event is provided in **Appendix C**.

Table 6-1 lists the climate hazard types identified as providing existing risk to County Carlow. This hazard type classification was adapted from IPCC[12].

[12] "Summary for Policymakers." In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, edited by V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, et al. Cambridge University Press, Cambridge, 2021. https://www.ipcc.ch/report/ar6/wg1/.

Table 6-1: Climate Hazards Identified for Carlow County

Type		Climate Hazards
Heat and Cold		Above Average Surface Temperature
		Heatwave
		Drought
		Cold Spell
Wet and Dry		Above Average Precipitation
		Extreme Precipitation
		River Flood
		Pluvial Flood
Wind		Severe Windstorms
Snow and Ice		Heavy Snowfall

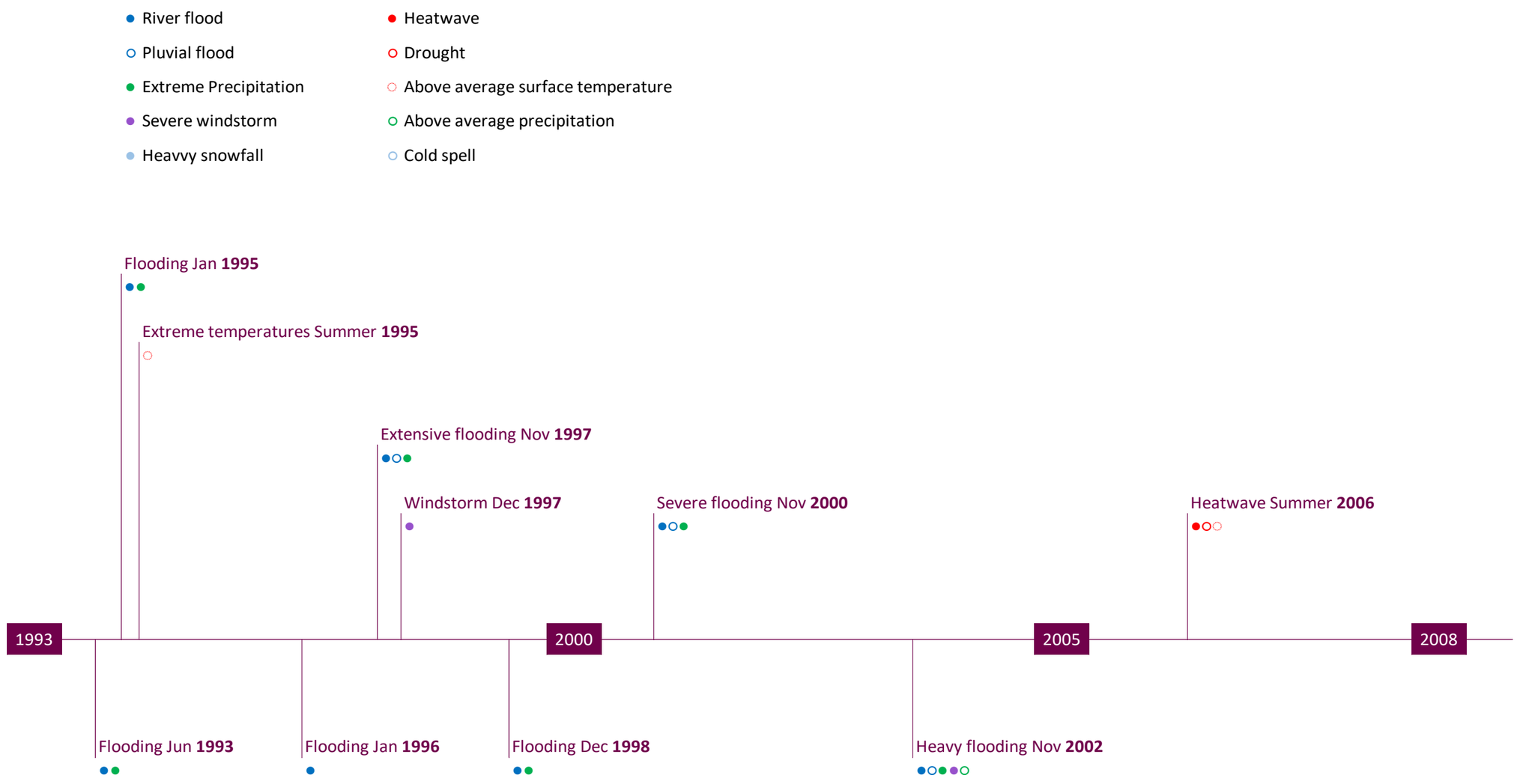


Figure 6-1: Profile of Climate Hazards in County Carlow: Representative timeline of climate hazards illustrated to show type of hazard and frequency 1993-2008

River flood
Pluvial flood
Extreme Precipitation
Severe windstorm
Heavvy snowfall
Heatwave
Drought
Above average surface temperature
Above average precipitation
Cold spell

Flooding and heavy rainfall Nov **2009**
Winter storms Winter **2009/10**
Storm Darwin Feb **2014**
Wettest Jan in 20yrs Jan **2016**
Storm Emma & Beast from the East Feb/Mar **2018**
Heatwave June/July **2018**
Storm Helene Sep **2018**
Storm Ali Sep **2018**
Storm Bronagh Sep **2018**
Storm Callum Oct **2018**
Storm Diana Nov **2018**
Storm Deirdre Dec **2018**
Storm Eleanor Jan **2018**
Storm Brendan Jan **2020**
Storm Ciara Feb **2020**
Storm Dennis Feb **2020**
Storm Jorge Feb **2020**
Prolonged Dry period Summer **2020**
Storm Ellen Aug **2020**
Storm Francis Aug **2020**
Storm Alex Oct **2020**
Storm Aiden Oct **2020**
Storm Bella Dec **2020**
Storm Malik Jan **2022**
Storm Corrie Jan **2022**
Storm Dudly Feb **2022**
Storm Eunice Feb **2022**
Storm Franklin Feb **2022**
Heatwave Summer **2022**
Flooding Aug **2022**
2008
2010
2015
2020
2023
Storm Frank Dec **2015**
Storm Barney Nov **2015**
Storm Brian Oct **2017**
Storm Ophelia Oct **2017**
Extreme cold spell Winter **2010**
Flooding Jun-Aug **2008**
Flooding Jan **2008**
Storm Elsa Dec **2019**
Storm Atiyah Dec **2019**
Storm Lorenzo Oct **2019**
Storm Hannah Apr **2019**
Storm Gareth Mar **2019**
Storm Freya Mar **2019**
Storm Eric Feb **2019**
Heavy rainfall Dec **2021**
Storm Barra Dec **2021**
Storm Arwen Nov **2021**
Storm Evert Jul **2021**
Heatwave & Prolonged dry period with heavy rain June **2021**
Storm Darcy Feb **2021**
Storm Christoph Jan **2021**

Figure 6-2: Profile of Climate Hazards in County Carlow: Representative timeline of climate hazards illustrated to show type of hazard and frequency 2008-2023

6.2 Characterising Climate Hazards

Understanding the nature and frequency of the identified climate hazards helps to produce a deeper appreciation of the scale of risk presented by each hazard type.

6.2.1 Description

A character profile was developed from available information for each of the identified hazard types. Whilst keeping to the scale of a Tier 1 assessment, geographical and spatial characteristics, including relevant specific details associated with past hazards events, are included where possible.

6.2.1.1 Flooding

The *National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action*[13] indicates that flooding represents one of the most immediate risks on a national basis, highlighting the significance of this hazard. According to *Climate Change Adaptation: Risks and Opportunities for Irish Businesses*[14], research in 2016 concluded that based on European projections, damage from flooding could amount to €1bn per year in Ireland.

In acknowledgement of the magnitude of risk that flooding presents to the county, Carlow County Council developed a Major Emergency Plan which covers advanced preparation, pre-flood actions, and flood awareness, highlighting the presence of flood risk[15].

6.2.1.1.1 River Flooding

River Flooding

River flooding occurs when the capacity of a river channel is exceeded, leading to rivers bursting their banks. This can be exacerbated by high tide levels impeding the flow of the river out into the sea. Factors influencing the severity of the flood include the size and slope of the catchment, the physical qualities of the soil and underlying rock, surface run-off, and drainage network.

Fifteen occurrences of significant river flooding in County Carlow are noted within the 30-year profile of climate hazards. Local impacts of flooding noted within the County include damage to critical infrastructure, reduced function of transport routes, increased maintenance and repair works, water quality impacts, environmental contamination, stress on biodiversity and environmentally sensitive areas in additional to ongoing socio-economic implications and pressure on overworked emergency response staff over prolonged periods.

Feb/Mar 2020

Elevated levels in Lough Derg led to closing the N65 Birr to Portumna

In 2011, as a requirement of the EU 'Floods' Directive, the National Preliminary Flood Risk Assessment[16] (PFRA) identified areas where the risks associated with flooding might be significant. Areas for Further Assessment (AFA) were progressed to the Catchment Flood Risk Assessment and Management (CFRAM) Studies in 2016, where more detailed assessment was undertaken to assess the extent and degree of flood risk more accurately. Where the significance of the risk was confirmed, possible measures to manage and

[13] Flood. S. et al., National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action, Report 346, EPA Research. 2020

[14] Karen Deignan et al., Climate Change Adaptation: Risks and Opportunities for Irish Businesses, Report 402 (EPA Research, 2022)

[15] CCC. Carlow County Council Major Emergency Plan. 2020

[16] OPW. The National Preliminary Flood Risk Assessment – Designation of the Areas for Further Assessment. 2012

reduce the risk were identified. Three locations in County Carlow were designated AFAs, these were: Carlow, Leighlinbridge, and Tullow.

Recent flooding of the River Slaney in Tullow Co. Carlow

A Flood Risk Management Plan (FRMP) for the Slaney & Wexford Harbour River Basin and an FRMP for the Barrow River Basin were both completed in 2018[17]. The plans set out the strategy, including a set of measures, for the cost effective and sustainable, long-term management of flood risk in the River Basins, including the areas where the flood risk has been determined as being potentially significant. The Plans includes feasible measures developed through a range of programmes or policy initiatives including: – Non-structural flood risk prevention and preparedness measures, structural flood protection measures for communities at significant flood risk, aimed at reducing the likelihood and/or degree of flooding, as identified through the National Catchment Flood Risk Assessment and Management (CFRAM) Programme[17].

In addition to the above FRMPs, 185 properties in Carlow were protected by a Flood Relief Scheme (FRS) in 2013 at an estimated cost of €7.4m. An additional 35 properties are also due to be protected through the ongoing Carlow FRS[17]. Outside of these larger schemes, minor mitigation works undertaken since 2010 include 23 no. projects at a combined cost of approximately €1.5m across County Carlow.

6.2.1.1.2 Pluvial Flooding

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[17]. As a result, there is overland flow of excess water leading to ponding in depressions in the ground, behind obstructions, or in man-made hollows. This type of flooding typically arises as a rapid response to intense rainfall before the flood waters eventually enter a piped or natural drainage system.

December 2021

8 evacuations in Tullow, verge collapses, rescues from floodwater

The collated record of hazard events for Carlow identifies nine instances of pluvial flooding in the past 30 years. Pluvial flooding is typically more localised than river flooding and occurs over a shorter time span. However, it has also been noted within Council to result in damage to critical infrastructure, reduced function of transport routes, increased maintenance and report works, water quality impacts, environmental contamination. Suspended material is known to block surface drainage systems which could lead to standing bodies of water and prolong the flooding period.

[17] www.floodinfo.ie

6.2.1.2 Extreme Precipitation

Extreme Precipitation

Extreme precipitation events are periods of rainfall occurring at a higher frequency and intensity than normal, often leading to flooding. There is also the possibility of water bodies being contaminated and having increased turbidity, reducing the water quality. Impacts that may arise due to extreme precipitation include the cancellation of any outdoor events, reduced ground stability, and storm water damage to buildings. Ireland has been monitoring rain levels since the late 1700s initially with two monitoring stations and has reached almost 500 active rain gauges to this day[18]. There are 21 cases of extreme precipitation events noted in the hazard events record, highlighting its regular occurrence.

Sep 2018

Storm Ali brought 60mm of rainfall in one day

6.2.1.3 Severe Windstorm

Severe Windstorm

Severe windstorms are strong wind events which may or may not be accompanied by precipitation. Infrastructure is particularly vulnerable to severe windstorms as strong winds can damage building facades or destroy habitats. The fallen debris can then be carried away and act as projectiles leading to further damage or serious injury. In the *National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action*[19], windstorms are listed as one of the priority climate risks in Ireland.

Storm damage, Carlow

January 2018

Orange warning issued with gusts of up to 130km/hr

The hazard events record shows a total of 39 severe windstorm events in County Carlow, the most regularly occurring climate hazard type in the County. Met Eireann typically send out alerts for high winds, and in 2020 alone, 9 separate alerts were issued.

[18] www.met.ie

[19] Stephen Flood et al., National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action, Report 346 (EPA Research, 2020).

6.2.1.4 Heavy Snowfall

Heavy Snowfall

Snowfall of 2018

Heavy snowfall is the large accumulation of snow usually accompanied with snow drifts. This can lead to precarious footing, potential road or building closure, or damage to infrastructure through excessive roof loading. A major concern from large amounts of snowfall is the serious damage to overhead powerlines and communication lines. This event is becoming less frequent, as the general warming of the atmosphere and oceans has reduced the volume of snow and ice. January and February are the typical months when snow is experienced, but it is not uncommon for snow to be present in the period from November to April[20].

There have been only three recorded heavy snowfall events in Carlow in the last 30 years according to the hazard events record. The most notable heavy snowfall event recorded was in February/March 2018 during Storm Emma and the Beast from the East. Blizzard conditions were witnessed in Carlow on the first three days of March.

Feb/Mar 2018

School and business closures

6.2.1.5 Heatwave

Heatwave

Summer 2022

Highest temperature in Ireland since 2003 at 29.2°C. Wildfires required helicopter bombing to be extinguished

The working national definition of a heatwave is five consecutive days or more with maximum temperature over 25 degrees Celsius[20]. Heatwaves can lead to a few issues, such as uncomfortable working conditions and the potential for heat stroke if there are inadequate measures in place to counteract the heat. There is a chance of a reduction in water quality as waterbodies may have a high concentration of dissolved material due to evaporation, and an increase in the risk of fires. The Fires, Land and Atmospheric Remote Sensing of Emissions (FLARES) project records the location and type of historic wildfires in Ireland and gives a visual representation of what areas have experienced wildfires, highlighting the need to monitor heatwaves due to its influence on wildfires[21].

In addition, heatwaves usually place recreational areas under stress, putting pressure on existing infrastructure. Another impact due to heatwaves is the altering of the road constitution, where the bitumen in the roads melt. A major concern with predicted changes in heatwaves is the cascading biophysical consequences they may have nationally and locally, e.g., a change in the growing season and changing the habitats that species depend on[20]. In the last 30 years, there has been evidence of four heatwave events experienced in Carlow based on the hazard events record.

[20] www.met.ie

[21] CCC, EPA, UCC, DOECC. Fire, Land & Atmospheric, Remote Sensing of Emissions (FLARES). 2021

6.2.1.6 Drought

Drought

Drought refers to the lack of access to water due to reduced water levels from high temperatures because of evaporation. This lack of water can prove to be detrimental to the county as drought is usually accompanied by high temperatures, and with it, high demand for water. If there is an inadequate supply of water, it will have to be imported by water tankers, which is a high-cost affair. With drought, there is also an increased risk in the transmission of diseases and a risk of treating water with too high a concentration of organic material. Additional emergency response callouts may also be experienced, leading to overworked employees, who are also being exposed to the impacts of drought. In addition, there is an increased risk of wildfires as a low moisture level in the soil leads to dried out vegetation.

Carlow Fire Service attending Fires on Mt. Leinster

June/July 2018

Only 0.2mm of rain in 38 days

There were four records of droughts being experienced in Carlow in the last 30 years according to the hazard events record. In June/July 2018, partial drought brought about extensive disruption to many farmers and their livestock in the area. The implementation of a hosepipe ban was brought into action for all domestic water supplies from the 6th of July and was extended until the 30th of September.

6.2.1.7 Above Average Surface Temperature

Above Average Surface Temperature

Above average surface temperatures are periods of heat exceeding the average temperatures of the given period over an extended span of time. Risks related to this event include the same risks found in both drought and heatwave events, but with more emphasis on increased stress on recreational areas, and less so on reduced water quality and supply. There is the same concern for the ecological structure of the county, as growing seasons will change, causing a shift from normal seasonal activities seen in nature, such as pollination and/or hibernation.

Summer 2006

warmest summer since 1995

In the last 30 years, there were four events in the hazard events record where above average surface temperatures were noticed. It is important to note that above average temperatures are not limited to summer. Drops in the frequency and/or intensity of snowfall events and the presence of warmer winters are linked to the increase in average surface temperatures[22]. During extended warm spells during the summer period the water supplying Hacketstown Water Treatment Plant through the mill race can be seriously affecting requiring intervention. Water Services has reported that the inability to satisfy demand is occurring more frequently.

[22] Stephen Flood et al., National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action, Report 346 (EPA Research, 2020).

6.2.1.8 Above Average Precipitation

Above Average Precipitation

Above average precipitation events are periods of rainfall exceeding the average rainfall of the given period over an extended span of time. Above average precipitation can lead to more time spent indoors which can affect mental health. A decrease in active travel may also be present which leads to increased use of vehicles running on fossil fuels. Drainage systems may be at risk of reaching capacity as they would be designed for a lower level of precipitation. Observations from the *National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action*[23] that average levels of national rainfall have increased by approximately 60mm (5%) for the period from 1981 to 2010 compared with the period from 1961 to 1990.

Nov 2009

more than twice the average rainfall for November

Four events in the hazard events record indicate above average precipitation levels in Carlow. The main issue for this increase in average precipitation levels is the increase in the risk of both pluvial and river flooding. Urban areas may not be designed to contain increased levels of rain and result in an increase in flood frequency.

6.2.1.9 Cold Spell

Cold Spell

Cold spells are events where temperatures reach record low temperatures over a short period of time. Cold spells can lead to uncomfortable working conditions if there is a lack of heat sources. Mental health is again a possible issue as less time would be spent outdoors. Water supply may be affected due to frozen water bodies or distribution lines. Cold stress on buildings is another possible risk of cold spells, causing infrastructure to crack. Based on Climate Indices from Met Eireann, cold extremes are becoming both less severe and less frequent[24]. Cold spells, based on the hazard events record, have been experienced twice in the last 30 years.

Winter 2009/2010

Coldest winter in almost 50 years with temperatures as low as -12.1°C

[23] Stephen Flood et al., National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action, Report 346 (EPA Research, 2020).

[24] www.met.ie

6.2.2 Frequency

Through development of the Climate Hazards Profile, the frequency of climate hazard types affecting County Carlow becomes more apparent. Using the classification categories adopted from Annex B shown in **Table 6-2**, the frequency of existing climate hazard types can be grouped into 5 broad categories. These have then been applied to the hazard types historically affecting County Carlow. The recorded information indicated that Severe Windstorms often combined with Extreme Precipitation, are the most frequently occurring climate hazards for County Carlow. **Table 6-3** presents the categorised frequency for each of the identified hazard types.

Table 6-2: Classifying the frequency of occurrence of climate hazards

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

Table 6-3: Frequency of Current Climate Hazards in County Carlow

	Climate Hazards	Occurrences	Frequency
	**Severe Windstorm**	**39**	**Very Frequent**
	**Extreme Precipitation**	**21**	**Very Frequent**
	**River Flooding**	**15**	**Frequent**
	**Pluvial Flooding**	**9**	**Common**
	**Heatwave**	**4**	**Common**
	**Drought**	**4**	**Common**
	**Above Average Surface Temperature**	**4**	**Common**
	**Above Average Precipitation**	**4**	**Common**
	**Cold Spell**	**3**	**Common**
	**Heavy Snowfall**	**3**	**Common**

6.3 Overall Impact to the Local Authority

For each of the climate hazards identified, the overall severity of impact for the following risk areas were estimated:

- Asset Damage,
- Health and Wellbeing,
- Environment (including biodiversity),
- Social,
- Financial,
- Reputation, and
- Cultural Heritage.

The criteria for assessment, as taken from Annex B, is provided in **Table 6-4**. The resultant current impact summary matrix showing the impact versus the frequency for the current climate risks is included in **Appendix E.** The overall level of impact is calculated as the average of impacts across the risk areas.

After producing the current impact summary matrix, the current climate impacts of hazards identified can be illustrated according to the current frequency of the hazard, as illustrated in **Figure 6-3**. This allows a simple visual communication of the key risks for the County and a starting point of which events to prioritise.

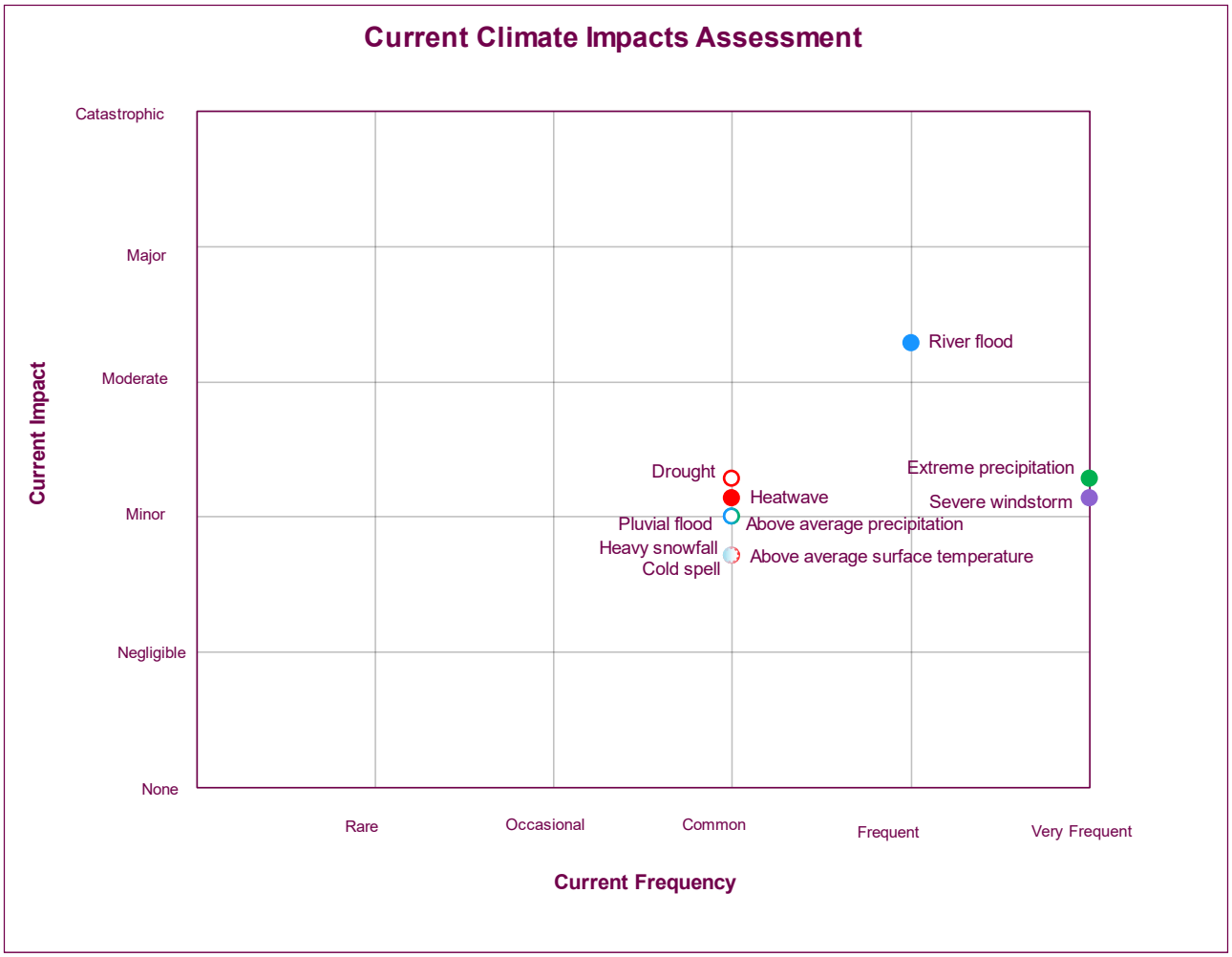


Figure 6-3: Current Climate Impacts Assessment Chart for County Carlow

Table 6-4: Magnitude of impact across various risk areas. Adapted from European Commission (2021)

Risk Area	Impact Level				
	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 shut down 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 physical or 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 one year. Limited prospect of full recovery
Social	No negative social impact	Localised, temporary social impacts	Localised, long- term social impacts	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)	< 2% of turnover	2-10% of turnover	10-25% of turnover	25-50% of turnover	> 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 national media coverage	National, long- term impact with potential to affect the 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

6.4 Characterising Impacts, Exposures, and Vulnerabilities

Throughout **Section 6.2** each of the identified climate hazards were characterised to provide on overall appreciation for the nature and scale of each hazard type. Through this characterisation, the national level research, local level environmental and engineering research and reports, the workshop held with the input from Carlow County Council Service Areas, and the developed climate history were all used to inform the Impacts, Exposures and Vulnerabilities at the local scale. **Appendix D** presents this collation of information into a tabular output.

For each of the extreme weather events and periods of climate variability identified through the climate hazards characterisation:

1. The impacts of the hazard are identified and described.
2. Specific exposures within each identified climate impact are detailed.
3. For each of the exposures, the associated physical, environmental, and socioeconomic vulnerabilities to the impact were assessed.

Table 6-5 describes each of the three vulnerabilities in more detail. It is important to note that vulnerability can increase or decrease the risk associated with a specific exposure.

Table 6-5: Vulnerability Types

Vulnerability Type	Description
Physical vulnerability	Properties of an asset related to the structure or facilities can exacerbate/reduce the impacts before, during, or after a hazard event, e.g., poor design and construction of building, provision of active cooling. **OR** Ability of a population/persons to access equipment or resources that can exacerbate/reduce the impacts before, during, or after a hazard event.
Environmental Vulnerability	Properties of the environment surrounding the asset/persons that exacerbate/reduce the impacts before, during, or after a hazard event, e.g., limited access to green space that provides respite during heatwave events.
Socioeconomic vulnerability	Properties of a population/persons related to the society, demographics, and economy that can exacerbate/reduce the impacts before, during, or after a hazard event e.g., low income, age, health, English language ability.

6.5 Impact Assessment

This CCRA is focused on the delivery of services and functions of Carlow County Council. For each of the identified climate hazard exposures, the level of disruption to the delivery of services and functions are identified and assessed. The impact assessment is provided within **Appendix D** and includes the perceived degree of impact on the delivery of services by Carlow County Council for each exposure in accordance with the high-level criteria for assessment shown in **Table 6-6**[25]. An overall impact score is calculated for each exposure based on a weighted average across each of the Service Areas. The higher the impact score, the greater the overall impact on service delivery and functions of Carlow County Council. This can be used to inform priority actions to address exposures which provide the greatest impact. The key to which can be to increase resilience through mitigation of the vulnerabilities which increase the severity of risks associated with a particular exposure.

As a Tier 1 qualitative study, this is a first-pass risk assessment to develop a quick and broad understanding of climate change risk. It is intended to provide the means to identify a need for strategic and ongoing responses/ commitments, to identify key localities for attention and to build awareness of risk among community and senior management. As it is a high-level screening, it is therefore not suitable for making any final decisions on adaptation actions but should be used to inform the general actions required.

Table 6-6: Description of the levels of impact due to the 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

[25] Edinburgh Adapts Steering Group, “Edinburgh Adapts: Climate Change Adaptation Action Plan 2016-2020,” 2016.

7 ASSESSING FUTURE CLIMATE RISKS AND IMPACTS

Understanding how climate change risks are likely to evolve in the future is crucial to identify how existing risks may be exacerbated by climate change or give rise to the emergence of new risks. To understand how climate change risks, and the subsequent impacts, might change into the future, it is useful to first consider how the frequency of climate hazards might change and how levels of impact may also change as a result of changes in the hazard, exposure, and vulnerability components of risk.

7.1 Future Changes in Climate Hazards

Any identification of climate hazards that are likely to be of significance in the future should begin with those that are significant in the present. To understand how levels of climate hazards might change in the future, available climate projection information needs to be examined to understand how the frequency and intensity of extreme weather events and periods of climate variability might change in the future.

For the purposes of adaptation strategy development, fine scale climate information and data is not required. National statements of projected climate changes and impacts are considered appropriate. More detailed assessment and appraisal should be employed when specific plans or measures are to be implemented and more detailed information is necessary.

The information required has been produced through nationally funded research projects, e.g., Nolan and Flanagan[26] and Desmond[27], and is summarised and available online through Climate Ireland.

National level information on projected changes in Ireland's Climate can be accessed through Climate Ireland's Essential Climate Information Tool.

National level information on projected changes in the biophysical impacts of climate change can be accessed through Climate Ireland's Climate Hazard Scoping Tool.

For each of the climate hazards identified through the assessment of current climate hazards and impacts, and based on available projection data, the projected frequency of each of the identified climate hazards was estimated. See **Appendix F** for projected frequencies of climate hazards.

7.2 Future Changes in Exposure and Vulnerability

Climate risks may develop or increase in the future because of the change in frequency and intensity of climate hazards. However, changes in exposure and vulnerability also affect future climate risks.

To establish future levels of impacts, available projections of non-climatic factors on a local level (e.g., County Development Plan, Local Area Plans, Local Economic and Community Plan etc.) were examined to assess potential changes in levels of exposure and vulnerability. Sources include the Carlow County Development Plan 2022-2028[28], and Carlow LECP Socio-Economic Profile[29] and Statement[30]. For some impacts, there was little existing information to support future impact and vulnerability assessment, resulting in estimates based on available information. See **Appendix F** for the assessment of projected changes in exposure and vulnerability.

[26] Nolan and Flanagan (2020) Research 339: High-resolution Climate Projections for Ireland – A Multimodel Ensemble Approach

[27] "National Preparedness to Adapt to Climate Change: Analysis of State of Play," 2018, https://www.epa.ie/pubs/reports/research/climate/Research_Report_256.

[28] CCC. Carlow County Development Plan 2022-2028. 2022.

[29] CCC. Carlow Local Economic and Community Plan Socio- Economic Profile. 2022.

[30] CCC. Carlow Local Economic and Community Plan Socio- Economic Statement. 2022.

7.3 Uncertainty

In assessing the future climate risks, there was a degree of uncertainty in how hazards, exposure, and vulnerability will change. Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of an event, its consequence, or likelihood. A range of data and information sources were used to mitigate uncertainty in the future risk assessment, but there is still a varying degree of uncertainty present. Therefore, when selecting evidence to inform the climate risk assessment, information related to the uncertainty of projected changes in climate hazards, exposure, and vulnerability are noted within the Rationale column of **Appendix F**.

7.4 Emerging Hazards and Climate Change Risks

Although some activities and services may not currently be affected by climate hazards, it is important to consider the full range of projected changes to hazard, exposure, and vulnerability as these changes may result in increased risk, leading to an exacerbation of impacts to the Local Authority. Following discussion with Carlow County Council and taking into account the character of Carlow and its assets, wildfires were noted as the key emerging climate hazard for the county.

The increasing risk of prolonged dry periods, above average temperatures and heatwaves is projected to lead to a continued reduction is soil moisture content leading to drier conditions and higher fuel loads.

Notes collected during the workshop demonstrate the increase in observed risk by the Fire Services and the changing nature of this risk. UCC have established a monitoring and recording programme to collate information about wildfires in Ireland[31] and should support the collation of data and impacts as this risk is projected to emerge.

- Fires, Land and Atmospheric Remote Sensing of Emissions (FLARES) undertaken by UCC aims to develop systematic approaches to the acquisition and collation of a range of data on agricultural and uncontrolled wildland burning burn events from satellite datasets.
- There has been a definite change in the types of fires been seen across the county in this year alone there has been three occasion to call on helicopters to put out wildfires on mountains and forests
- In addition to more wildfires there is also a higher risk from fires in urban areas that can quickly become out of control due to dry conditions in green areas.
- There is a significant draw on resources to respond to calls related to climate hazards (approx. 40-50% of calls) which puts added pressures on the fire service to respond to their baseload.

7.5 Overall Future Impact on the Local Authority

For each hazard and each impact category (Asset Damage, Health and Wellbeing, Environment, Social, Cultural Heritage, Financial, and Reputational), the projected level of impact has been estimated and the rationale for this provided using the national level research. This future impact assessment accounts for projected changes in hazard, exposure and vulnerability and assumes that no additional adaptation actions are taken to offset future impacts. See **Appendix G** for the Future Impact Summary Matrix showing the projected impact versus the projected frequency for the future climate risks. The level of impact is calculated as the average level of impact across the impact categories of Asset Damage, Health and Wellbeing, Environment, Social, Financial, Reputation, and Cultural Heritage.

[31] CCC, EPA, UCC, DOECC. Fire, Land & Atmospheric, Remote Sensing of Emissions (FLARES). 2021

7.6 Future Climate Impacts Assessment Summary

After producing the Future Impact Summary Matrix, the future climate impacts of hazards projected to impact Carlow's Local Authority can be presented according to the future frequency and future level of impact of the hazard, see **Figure 7-1**. The level of future impact is calculated as the average level of impact across the impact categories of Asset Damage, Health and Wellbeing, Environment, Social, Financial, Reputation, and Cultural Heritage. This allows for the simple communication of the key risks that are projected for the County and how to prioritise them.

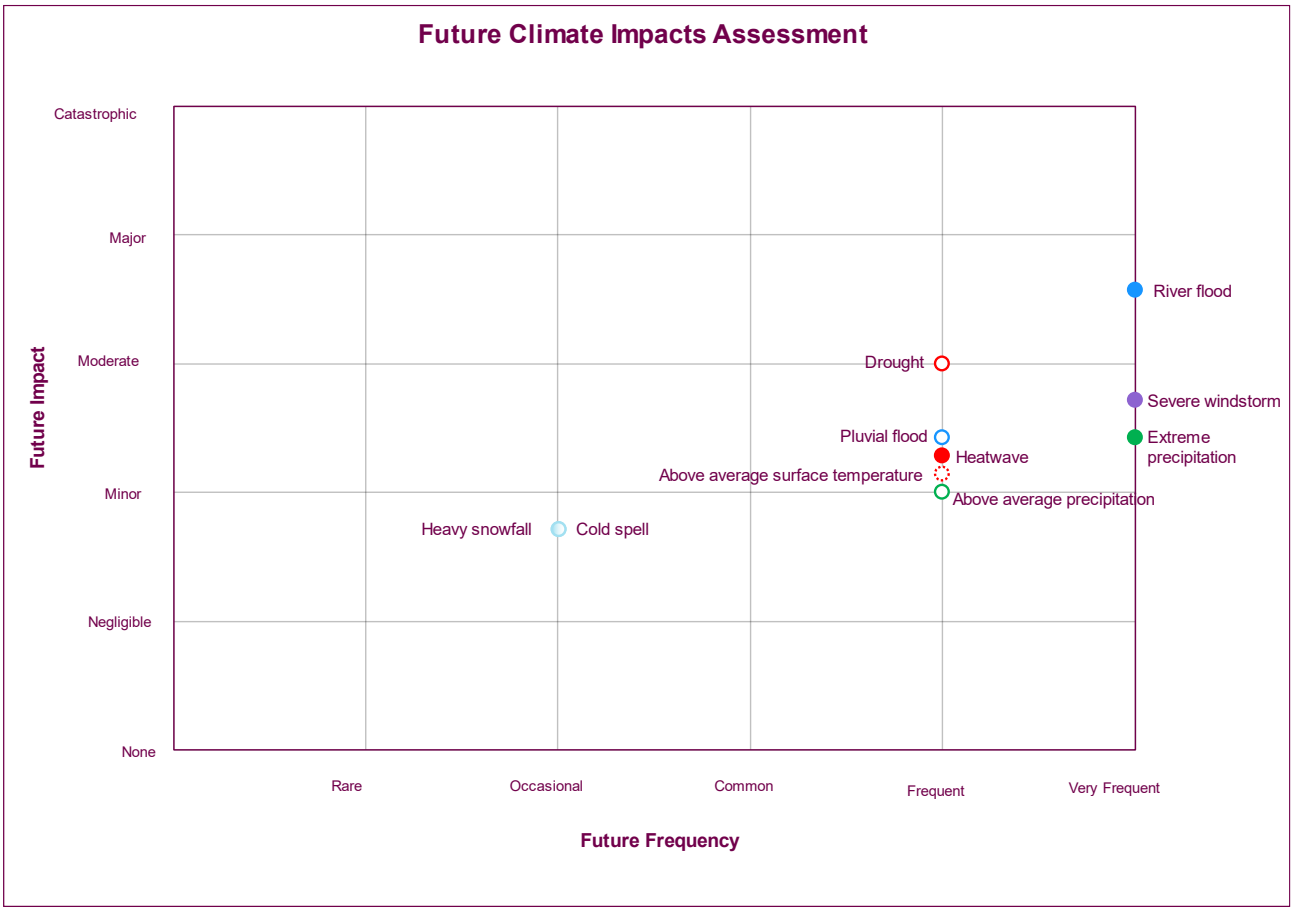


Figure 7-1: Future Climate Impacts Assessment Chart of County Carlow

8 SUMMARY AND CONCLUSION

This CCRA Report summarises the steps undertaken to assess the climate change risks within Carlow County Council. The more detailed tabular risk assessment outputs are included in the Appendices.

A CCRA is integral to informing the preparation of the Local Authority Climate Action Plan by identifying and prioritising current and future risks. It assists in the identification of possible adaptation responses to reduce or remove climate change risks within the Local Authority. Accordingly, the climate change risk assessment sits as part of the evidence base to support the local authority climate action plan.

As a Tier 1 qualitative study, this is a first-pass risk assessment to develop a quick and broad understanding of climate change risk. It is intended to provide the means to identify:

- a need for strategic and ongoing responses/ commitments:
- key localities for attention and
- to build awareness of risk among community and senior management.

As it is a high-level screening, it is therefore not suitable for making any final decisions on specific adaptation measures but should be used to inform the general actions required. Carrying out a semi-quantitative (Tier-2) or quantitative (Tier-3) risk assessment would provide a greater level of information and support on which to base adaptation decisions.

Throughout this CCRA, the publicly accessible national level research, local level environmental and engineering research and reports, the workshop held with the input from Carlow County Council Service Areas, and the developed climate history formed the evidentiary basis for assessment.

During the workshop, a common trend seen in Carlow is budgeting constraints. There is strategic planning in place to determine what projects can be done across the county with the annual budget available but the increased frequency of emergency works being required is having a significant impact on available funding as the money must be pulled from budgets of other planned projects or services budgets.

Key Climate Hazards identified for County Carlow:

River Flooding

Extreme Precipitation

Drought

Future projections of climate change indicate that Above Average Precipitation, Prolonged Cold Periods and Heavy Snowfall will remain relatively consistent with existing conditions. However, risk is predicted to increase for all other identified climate hazards, with River Flooding remaining the perceived highest risk to County Carlow.

8.1 Recommendations

- This assessment has developed a quick high-level understanding of climate change risk. However, to support the effective implementation and management of adaptation action, future risk assessments should transition from a qualitative (Tier-1) study to a semi-quantitative (Tier-2) or quantitative (Tier-3) approach, to provide a greater level of information on which to base adaptation decisions.
- It was noted during the workshop that most costs due to the resultant impacts of climate hazards are not typically budgeted for and it would be very helpful to provide a separate operational cost code for emergency or repair works due to certain events be provided to each service. This will allow the true cost of storm events and climate events to be calculated and facilitate future contingencies in budgets and climate adaptation funding etc.
- The data gathering phase of this assessment identified that there is no systematic approach within Carlow County Council to record climate related observations and records in an indexed or easily accessible method. It would be recommended that all Service Areas within Carlow County Council adopt a consistent approach to recording service disruptions, mitigation and recovery measures implemented, and associated costs for any areas within their remit, and that CCC produce an annual summary report documenting all climate hazard impacts across all Service Areas.

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Appendix A Risk Assessment Tiers

	First-pass risk assessment	Second-pass risk assessment	Third-pass risk assessment
Objective	Develop a quick high-level understanding of climate change risk to determine whether or not further research or adaptation planning is required at this time	Conduct a risk assessment (generally involving expert judgement) to identify specific risks that may become problematic under future climate change	Understand the vulnerability of different systems exposed to climate change-related hazards using more detailed and finer scale data; conduct a detailed risk assessment (quantitative or qualitative) to identify specific risks of different systems
Time and resource requirement	Minimum	Moderate	High
Data requirement	Nationally available datasets, which may be in published sources (e.g. summary regional projections and/or visualisations of climate and sea level variables). Available localised mapping and information. Data should be available at no cost	Nationally available climate change datasets, both observed and projected (e.g. from national meteorological centres), together with existing information available from government (e.g. local municipality) studies and/or expert knowledge. Data should be available at no or low cost	Some site-specific data (depending on the objective of the assessment and may not be necessary every time), e.g. lidar (light detection and ranging) data, in conjunction with high-resolution (daily, spatially explicit) climate scenario data and local expert knowledge to understand the exact scale of the risk. A substantial cost may be involved
Base knowledge requirement	• Minimum expertise required to acquire data • Local knowledge required to interpret data • Some understanding of climate change and its potential risks (readily available in many decision support tools such as Climate Ireland)	• Moderate knowledge required to acquire appropriate data • Moderate expertise required to interpret data • Moderate expertise required to understand the consequences of a specific climate risk	• High level of expertise required to acquire site-specific data (may not be necessary for all assessments) • High level of expertise required to apply data and analyse and interpret results • High level of expertise required to understand how a given climate risk can translate into a number of consequences for business
When should it be used?	• To develop a quick and broad understanding of climate change risk • To identify a need for strategic and ongoing responses/ commitments • To identify key localities for attention • To build awareness of risk among community and senior management • To seek a social and organisational licence to act on adaptation	• To develop a more detailed understanding of climate change risk and opportunities for a community or organisation • To identify key risk localities with follow-up resourcing requirements (e.g. new data, new study) • To get buy-in from community or senior management for developing an adaptation strategy or plan • To produce targeted climate risk communication materials • To identify adaptation options and support development of a plan or strategy	• To produce detailed impact studies of climate change effects on specific installations and activities, with a full understanding of the probabilities and uncertainties involved • To estimate the costs of adaptation action and prioritise resource allocation • To confirm emergency response procedures/requirements • To develop strategic and economic evaluations of adaptation options • To develop adaptation action plans for specific issues, including supporting detailed design
Limitations	Based on high-level screening and therefore not suitable for making any final decisions on adaptation actions	Based primarily on qualitative expert judgement of risk and therefore the results are as good as the qualitative judgement of the experts	Resource and time intensive, therefore requires expert input

Source: National Risk Assessment of Impacts of Climate Change: Bridging the Gap to Adaptation Action (EPA, 2020)

Appendix B Workshop Notes

Notes

Innishmore, Ballincollig
Co. Cork P31 KR68
T +353 21 466 5900

Reference:	IE000586A
Workshop Name:	CCRA Workshop Notes - Carlow County Council
Workshop date:	23 November 2022
Workshop location:	Carlow Town Hall

Attendees

Name	Initials	Sector/Service
Ciaran Brennan	CB	Carlow Municipal District
Bernard Duff	BD	Finance
Tadgh Madden	TM	Environment
Barry Dowling	BD	Muinebheag Municipal District
Michael Brennan	MB	Housing/Community/Recreation/Amenity
Seamus Loughlin	SL	Active Travel/Roads
Padraig O Gorman	POG	Roads/Water/Emergency Services
James Byrne	JB	Water Services
Jannette O Brien	JOB	Climate/Environment
Ray Wickham	RW	Roads & Transport
Brendan Doyle	BD	Housing
Sara Jane Condon	SC	Planning
Liam Carroll	LC	Fire Services
Padraig Cahill	PC	Housing & Civil Defence
Gerrard Doyle	GD	Water & Civil Defence
Eamonn Brophy	EB	Corporate Services
Donnacha Lynch	DL	Environment
Barry Knowles	BK	Carlow Municipal District
Tim Cooke	TC	RPS
James Peters	JP	RPS
Aidan Ware	AW	RPS

Notes

Effects on Services:

TC invited each attendee to discuss what they saw as the biggest impacts on their service due to climate change and were asked to identify the hazards impacts, exposures, and vulnerabilities.

Carlow Municipal District:

- There is a large draw on resources for the increased demands on the management of parks, green areas, seasonal planting etc. in particular for watering during long dry periods and the warmer summers we are experiencing. There is a lot of money spent to put these in place, so the upkeep and maintenance is required to protect the investment made and keep them looking attractive for use by the public.
- As the climate is changing the use of seasonal planting may need to be addressed as it is a high cost to plant and maintain. Exploring more resilient planting in green areas and using those better suited to the climate would require less upkeep, reduce the draw on resources, and could be more sustainable.
- Rainfall is more tropical in nature these days and a direct result of this is more localised flooding as infrastructure cannot keep up with removing the rainfall and areas that never experienced flooding in the past are now flooding. A comment was made that even if there is no blockage of gullies or pipes, there is still a major issue as the capacity in the drainage network is not there for these intense downpours.

Finance:

- A flood relief scheme installed in Carlow town in recent years represented the most significant capital investment into climate change adaption in recent times.
- Finance plays a key role in the approach to adapting and mitigation against climate changes in terms of budgeting for projects as well as trying to budget for contingencies for emergency works that may crop up during the year after damage to infrastructure to hazard events.
- The impacts of rivers flooding and the damage it causes has been the most significant drain on funds in recent times including the requirement for the flood relief scheme in Carlow town.
- There is strategic planning in place to determine what projects can be done across the county with the annual budget available but the increased frequency of emergency works being required is having a significant impact on available funding as the money has to be pulled from budgets of other planned projects or services budgets.
- There is an issue in relation to gaining insurances in flood prone areas and the council see this as a growing issue as flooding is occurring in areas where it has not in the past. Once an area has been subject to flooding, insurance companies will likely increase insurance prices by a large amount.
- A comment was made around rates collected by the council and if they are affected by businesses being impacted by flooding, weather events etc. They are not but there are always complaints received form business if they have to close and look for a reduction in rates if it's for a long period of time.

Landfill:

- Civic Amenity sites must close during high winds due to the H&S of the public bringing waste to the site and the staff operating the site. Closing the sites can impact on where the rubbish is dumped in some cases.
- There are some capped landfills in the county, the gas collected from these is flared as the gas is not of good enough quality for energy generation.
- There are leachate collection systems in place which store the leachate in lagoons which is the removed offsite for treatment. The leachate coming off the landfills is slowly reducing over time, and they have no issues with the impacts of climate change on the management of the leachate run off.

Muinebheag Municipal District:

- Muinebheag Municipal District is primarily a rural area, and the hazard of most concern is flooding and the potential it has to cut off communities.
- Due to increased rainfall events and an increase in their intensity there has been a noted increase in pluvial flooding on tertiary roads where run-off from land banks is collecting on the roads and flooding

them as they either have no drainage network or insufficient capacity to deal with the quantity of the run-off coming off the land.

- Blockages of drainage systems is a big issue which can exacerbate the flooding experienced.
- The impact on the roads is typically short-term closures with temporary diversions, however diversion can be quite long and add considerable time to journeys given they are in a rural area with limited options.
- The increased damage seen on tertiary roads was also noted and the main cause is due to pluvial flooding as mentioned above. All the issues in relation to damage from flooding on roads and intense rainfall mentioned by other councils were brought up.

Housing and Community:

- Parks have to be closed during periods of bad weather with the biggest culprits being intense rainfall and high winds (typically associated with weather warnings from met Eireann).
- There is a retrofit scheme in place on the LA housing stock (approx. 2000 houses) to improve their energy efficiency. It was noted that air to water is the primary heating source that they are installing on houses and they have been experiencing issues with the length of time that houses take to re-heat after a power outage (same issues as brought up by Kilkenny and Tipperary).
- A comment was made relating to the need for more thought going into the suitability of seasonal planting in the public realm and how it needs to be made more resilient by justifying if its needed (where & why); looking at planting more resilient species that are drought resistant and don't need as much maintenance to keep areas looking well; planting of more trees in areas rather than just seasonal planting that lasts a few months. By planting more sustainable trees and vegetation as opposed to seasonal planting, there is a potential for an improvement in air quality.
- The drive to passive housing in recent times could be a potential vulnerability to the housing stock in the future as they may have issues with cooling in increased temperatures and may not be suited to the future climate.
- Reactive maintenance has increased significantly over recent years due to the damage being done by storm events.
- The older housing stock is becoming an increased risk to climate events and this is made more vulnerable by the fact they are typically populated by the older and poorer groups within the community.
- Lack of temporary housing available for tenants affected by flooding events.

Active Travel:

- There is increased instances of flooding of roads and in particular the more rural network and tertiary roads.
- Higher temperatures and heatwaves are being experienced which are having an impact on surface dressing of roads, heaving of footpaths and road surfaces. This tends to have a disproportional effect on active travel as these issues that vehicles may be able to avoid or drive through can be a much bigger worry for cyclists and pedestrians and also be a much higher risk to their safety if the designated walkways/cycleways are affected and they need to go out into the main road.
- In 2016 there was significant flooding which caused damage to bridges and infrastructure in the county.
- Active travel is typically more exposed to the impacts of climate change as it is exposed to the elements. Additionally, in the aftermath of storm events the clear ups focus firstly on clearing roads and the debris can be pushed onto footpaths and cycleways preventing active travel for longer periods of times.
- 80% of the cycleways in the county are mostly roadside tracks where space is not available to seperate them from the trafficked roads.

Roads/Environment/Water/Emergency Services:

- The frequency and intensity of weather events and impacts of climate change are increasing across the board.

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- The monitoring and preparation for weather events, flooding etc is becoming an increased stress on resources and is almost a job in itself across the county. It is something that is drawing more and more resources which has a financial cost as well as a cost of pulling resources away from their day-to-day duties.
- Services during prolonged periods of bad weather and storm events become really stretched and come under significant pressure.
- An increasing amount of the annual funding is being used up reacting to climate events and their impacts on the county and this draws funds away from the planned annual spend. Access to national funds can be difficult unless it is a widespread incident that has affected a lot of the county meaning that in most cases the money for emergency works has to be sourced from the council's annual budget or go hat in hand to other sources of funding.
- The existing measures put in place to mitigate against the impacts of climate change need to be re-examined in some cases. An example given was the flood relief scheme put in place in Tullow over a decade ago, since then the river levels have been continually rising and the risk of flooding from the Slaney is now a concern of the council.
- As Carlow has no coastline the majority of swimming waters are on rivers, and this presents a major risk for public safety. They can be picturesque on a good day but can change quickly and be extremely dangerous during or after flooding events.
- Existing infrastructure struggles to cope with the intensity of the weather events being experienced, in particular storm networks coping with intense rainfall.
- The H&S of people responding to emergencies be it emergency services or council crews is becoming more of an issue due to the increased risks they are facing. Weather events are becoming increasingly extreme and as a result the hazards to personnel safety are increasing and mobilising crews is putting people in more risk than what would have been seen in the past and on a more frequent basis.
- Concern of electric vehicles combusting due to battery problems if adopting electric vehicles.

Environment and Climate Action:

- There is increased pressure on SAC's & SPA's due to increased population movements and development of infrastructure etc.
- The changes being experienced in Irelands climate is beginning to favour invasive species, both flora and fauna, and as a result are outcompeting native species at a quicker rate. It is not 100% known what exact changes are facilitating this (ongoing research) but it is thought that the primary driver is the increasing temperatures and changes to the growing season.
- The increased frequency of flooding events and more intense rainfall is also aiding in the spread of invasive species seeds and spores aiding them in spreading to new areas.
- There was a comment made in relation to how Ireland will be able to deal with large scale population movements across the globe as areas become harsher for humans to live in and they start to move to different areas and the potential effect this may have on our future population and how can this be dealt with appropriately planned infrastructure.
- Air pollution & air quality is something that is being impacted by climate change, as dry spells are increasing the incidence of dust in the air.
- There is increasing reputational damage for Carlow County Council as there are public expectations placed on the Local Authority to resolve issues that are ultra vires. This brings a sharp focus on the effects on reputation of the council and having to go above and beyond to keep good relations with the public.
- Communication & transparency with the public plays a vital role to ensure that the public knows the reasoning behind why things are being done and how long they will be impacted etc.
- The changes being experienced in Irelands climate is causing a significant increase in the pollen count in the air which is affecting people's health and wellbeing.
- A very valid point raised is the fact that the impacts that are experienced along rivers are typically a result of upstream events that are not in the control of the local council and limits what the council can do

Notes

in order to prevent the impacts they experience in their county. Invasive species was used as an example where the river can carry seeds downstream but if not dealt with at source they will continue to be an issue even if there is something being done downstream.

- There needs to be a linked thinking across counties and even at a national scale to allow a coordinated approach to dealing with impacts along the extent of rivers.

Water Services:

- The existing storm network relies on storm water pumps in some areas, and these can struggle to cope with the flows being experienced due to increased intensity of rainfall events. Failure of these pumps would result in significant flooding and is exacerbated by the fact that some are on combined networks.
    - Maintenance programme for these pumps is critical and must be kept on top of and kept up to date.
- Irish Water taking over the operation of water services is a major vulnerability as the council are now reliant on a third party for water supply and wastewater collection and treatment. Communications between IW and all council services will be key in decreasing this vulnerability.
- Drinking water supplies are coming under increased pressures due to longer dry spells, increased temperatures and droughts that have been experienced in recent years.
- Given a large portion of the wastewater network is combined the increased storm flows through can have a significant impact on the storm management systems in place at WWTP and result in significant overflows of untreated effluent directly to the environment.
- In Carlow town there are 4 major storm water PS relied upon during flooding events and none of these have permanent stand-by power generation making them vulnerable to power outages. The council only have one portable generator in the area and have to rely on renting another 3 to have them on stand-by during potential flood events so there is a significant reliance on the availability of these generators, access to be able to get them to site, and people being available to get them in place etc.

Roads:

- Funding remains a significant barrier for a small County like Carlow who depend on external funding sources due to a limited local rate base. Works to be carried out outside of the annual budgeted works programme are often delayed due to lack of financial resources.
- Rivers susceptible to flooding in the county are varied. The Barrow has a very slow rise and fall while others rise and fall “like a fiddler’s elbow” which causes different issues and different ways of reacting to flood events and the approach to preparing and reacting to the events.
- A big issue on the road network, particularly tertiary roads, is the lack of maintenance on open drains and culverts resulting in increased incidences of flooding.
- Roads are currently pre-treated (salted) for cold weather circa 5 times per year. Stock shortage issues experienced in 2009/2010 have been resolved. However, issues in accessing materials from national storage depots for local use is ongoing.
- Increasingly high volumes of snowfall experienced three times over the last decade resulted in engaging of contractors who provided specialist equipment. This had a significant impact on budgets and finances of Carlow County Council.
- While the thaws experienced in these snowfall events were slow, the thawing resulted in very soft ground conditions. Issues have arisen in the clear up process where areas are inaccessible due to the soft, unstable ground conditions. The substructure of roads and bridge foundations can also be affected by the instability of soft ground conditions, leading to potential collapse.
- Higher surface temperatures can result in increased wear and tear of roads surfaces, particularly on bitumen based surfaces and surface dressed roads. During hot weather HGV’s passing over these surfaces can cause large sections to be ripped up.
- Damage caused by storm events and climate impacts to the roads infrastructure must be fixed but there is no guarantee of re-cooping the money spent from national funds or other sources. As such there is a risk to the annual budget of the roads department potentially impacting on what projects can be completed or even on annual maintenance programme.

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- There is a requirement for the improvement of the storm network across the county to mitigate against pluvial flooding and intense rainfall events. As has been seen in other counties this issue has resulted in more localised flooding being experienced.

Strategic Planning:

- The main point made by the planning dept. was that the planning framework and strategic planning accounts for climate change and is to the fore of the planning process.

Fire Services:

- The frequency of call outs has increased over recent years and being called out to more non-life-threatening events that are directly caused by climate hazards such as flooding, storm damage etc. The fire services in Carlow respond to all calls - they do not have a procedure in place similar to Tipperary where they wait for the storm event to subside before responding to non-life threating calls.
- There has been a definite change in the types of fires seen across the county in this year alone. There have been three occasions to call on helicopters to put out wildfires on mountains and forests.
- The increased incidences of wildfires are putting SAC's & SPA's at more risk.
- In addition to more wildfires there is also a higher risk from fires in urban areas typically in relation to anit-social behaviour and setting small fires that can quickly become out of control due to dry conditions in green areas. Typically, if this happens once it happens a number of times as there are people copying the acts of others after seeing the impact it had.
- Call outs to storm events have become more frequent and they are experiencing more severe impacts making going out in them more dangerous.
- A statistic of note is that due to the increased incidence in flooding events and the need for entering flowing water the number of members trained in this has increased from 5 to 18 in the last number of years.
- As mentioned previously and by other councils the incidence of localised flooding is becoming more and more common and flooding in areas that have not experienced it before.
- There is a significant draw on resources to respond to calls related to climate hazards (approx. 40-50% of calls) which puts added pressures on the fire service to respond to their baseload and life threating emergencies and significantly impacts on response times which can cost lives.
- A wildfire on mount Leinster in August 2022 required 38 fire fighters from four stations for the day and in any other emergency during that period, the response time would have been impacted by a minimum of 1hr. It was noted that the fire services went from one of the biggest fires they have fought in years due to prolonged dry spell and increased temperatures to having to enter flood water to rescue people approx. 3 days later due to the River Barrow bursting its banks due to intense rainfall.
- Fires, Land and Atmospheric Remote Sensing of Emissions (FLARES) undertaken by UCC aims to develop systematic approaches to the acquisition and collation of a range of data on agricultural and uncontrolled wildland burning burn events from satellite datasets.

Civil Defence:

- Flooding of an apartment block in 2008 was the largest call out that they have had for many years. Typically, they are called out for snowfall and flooding events but can be called upon for anything and everything the council and emergency service need support with.
- As experienced in other counties there is a huge demand on the crews and they are reliant on volunteers. They have a major role in supporting vulnerable communities that become cut off due to climate hazards, transport of fuel and supplies, transport too and from medical services, getting personnel in and out of areas, meals on wheel, etc. it is a big draw on resources during storm events. They are seeing the need for these services increasing due to an increase in storm event frequency and intensity.
- Undertaking standard tasks that the civil defence are responsible for can become very difficult in the more severe weather events being experienced and can affect their ability to efficiently search and rescue.

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Corporate Services:

- There is a crisis management team gathered during any emergency event and they are responsible for communications and organisation of the council services during the emergency event.
- The county hall is used as the base of operations, and it has a backup generator in the event of losing power.
- They have dedicated mobiles for the team as well as critical people within the services who are out in the field and have a number of back up GPS phones if the mobile network goes down.
- The crisis management team is based on LA staff volunteering and it is a big ask for people to take this on. As events are lasting longer periods of time there is more of a demand on these resources for longer periods of time which can impact the amount of people volunteering in the first place or volunteering again.
- COVID has bolstered the ability for business continuity with more people able to work from home.

Appendix C Hazard Events Record

Hazard Events Record - County Carlow				Hazard Type									
Year	Date	Event	Summary	River flood	Pluvial flood	Extreme precipitation	Severe windstorm	Heavy snowfall	Heatwave	Drought	Above average surface temperature	Above average precipitation	Cold spell
2022	16th August	Flooding	Extensive flooding in County Carlow. Businesses and homes damaged by floodwaters in Carlow Town, Tullow and Muine Bheag. Red Cross Humanitarian Support Scheme activated.	■									
2022	Summer	Heatwave	Extensive fires across County Carlow for much of the summer including a large gorse fire on Mt Leinster on August 13th requiring helicopter water bombing to extinguish. Extensive damage to SAC. Highest temperature in Ireland was reached in Oak Park Co Carlow, where the mercury hit 29.2C. This is the highest August temperature in Ireland since 2003, and 9.3C above its 1981-2010 long-term average, according to Met Éireann. Top water level of the wells at Oak Park were affected by the sustained dry weather and also by irrigation activities on nearby vegetable crops.						■				
2022	February	Storm Franklin	Gale force winds and severe gusts				■						
2022	February	Storm Eunice	Gale force winds and severe gusts				■						
2022	February	Storm Dudley	Gale force winds and severe gusts				■						
2022	January	Storm Corrie	Gale force winds and severe gusts				■						
2022	January	Storm Malik	Gale force winds and severe gusts				■						
2021	25th December	Heavy Rainfall	Widespread flooding across County Carlow. 8 no. homes evacuated in Tullow. Verge collapses in Hacketstown. Family rescued from vehicle stranded in floodwater at Knockmulgurry. Blackstairs Mountains	■	■	■							
2021	December	Storm Barra	Gale force winds and severe gusts				■						
2021	November	Storm Arwen	Gale force winds and severe gusts				■						
2021	July	Storm Evert	Gale force winds and severe gusts				■						
2021	June	Heatwave & prolonged Dry period with heavy rain	loss of water supplies in private wells. Some supply interruptions due to high demand. Following this prolonged dry period and shortly after a very heavy rain event in the Wicklow Mountains a plume of inert material that was washed off of the Wicklow Mountains which flowed down the River Slaney and affected the Water Treatment Plant Rathvilly. The water that was high in turbidity and as a result the largest Boil Water Notice ever County Carlow was issued and stayed in place for 2 weeks, causing major upheaval to all affected customers.			■			■	■			
2021	February	Storm Darcy	Gale force winds and severe gusts, ice and snow conditions				■	■					
2021	January	Storm Christoph	Flooding and Heavy Rain		■	■	■						
2020	December	Storm Bella	Gale force winds and severe gusts				■						
2020	October	Storm Aiden	Gale force winds and severe gusts				■						
2020	October	Storm Alex	Heavy Rain, thunderstorms and gusty winds			■	■						
2020	August	Storm Francis	Heavy Rain, thunderstorms and gusty winds			■	■						
2020	August	Storm Ellen	Heavy Rain, thunderstorms and gusty winds			■	■						
2020	Summer	Prolonged Dry period	Water Treatment Plant at Raheenleigh was unable to satisfy the demand in the central region. To assist in maintaining water supplies to properties some network adjustment was necessary to feed the Central Region from the Northern region. This additional water was insufficient to cover the increased demand and it was necessary to tanker additional water from Leighlinbridge Water Treatment plant to Myshall Reservoir to ensure an uninterrupted supply of water to all properties. This also has an environmental impact of generating additional emissions through the unnecessary haulage of water. Hosepipe ban was issued in June.							■	■		
2020	February	Storm Jorge	Gale force winds and severe gusts				■						
2020	February	Storm Dennis	Gale force winds and severe gusts				■						
2020	February	Storm Ciara	Heavy Rain, thunderstorms and gusty winds			■	■						
2020	January	Storm Brendan	Heavy rain, thunderstorms and gusty winds			■	■						
2019	December	Storm Elsa	Gale force winds and severe gusts				■						
2019	December	Storm Atiyah	Gale force winds and severe gusts				■						
2019	October	Storm Lorenzo	Gale force winds and severe gusts				■						
2019	April	Storm Hannah	Gale force winds and severe gusts				■						
2019	March	Storm Gareth	Gale force winds and severe gusts				■						
2019	March	Storm Freya	Heavy snowfall and blizzard conditions were witnessed in County Carlow				■	■					
2019	7th February	Storm Eric	Yellow wind warning placed on Co. Carlow, Southwest-West winds of 50-65km/hr, mean windspeed and gusts of 80-110 Km/hr in Co. Carlow				■						
2018	2nd January	Storm Eleanor	Co. Carlow was issued an orange weather alert for the most of this storm. High gale force winds and gusts of up to 130km/r were experienced along the South-East. As a result of high winds and heavy rain, much destruction of property was experienced right across the South-East region of Ireland			■	■						
2018	15th-16th December	Storm Deirdre	Mean wind speeds in the Southeast reached 55-65km/hr & gusts up to 100 km/hr. Both the River Derry and Dereen in Carlow were flooded causing nearby areas to experience flood impacts	■			■						
2018	28th November	Storm Diana	Yellow wind warning in place for Co. Carlow, Power outages mostly affected Pollerton, Tullow and Hackettstown with over 100 ESB customers without power. Fairgreen shopping Centre also closed for a short period of time.				■						
2018	12th-13th October	Storm Callum	Gales of up to 130km/h were experienced in parts of the Country and localized flooding. Carlow was issued a status yellow wind warning		■		■						
2018	20th September	Storm Bronagh	Mean wind speeds between 65 and 80 km/h with gusts between 110 and 120 km/h in parts of the Country. Carlow was issued a status yellow alert				■						
2018	19th September	Storm Ali	Brought about rainfall of up to 60mm in the Southeast of Ireland			■	■						
2018	17th September	Storm Helene	Humid spell of wet & windy weather was experienced in Co. Carlow as the passing of former hurricane Helene which initiated in the Atlantic became a surge of tropical storms.			■	■						
2018	June/July	Heatwave	Oak Park weather station recorded an 11-day heatwave in late June, the longest heatwave in the last 20 years. Partial drought was experienced in Co. Carlow where only 0 .2mm of rain had fallen over a period of 38 days. Carlow held the record longest heatwave in the Country on the 5th of July with mercury soaring at Oak Tree station for 11 days straight since the 24th of June. A total of only 47.7mm of rain fell within June and July. This						■	■	■		

Hazard Events Record - County Carlow				Hazard Type									
Year	Date	Event	Summary	River flood	Pluvial flood	Extreme precipitation	Severe windstorm	Heavy snowfall	Heatwave	Drought	Above average surface temperature	Above average precipitation	Cold spell
			partial drought brought about extensive disruption to many farmers and their livestock in the area. As a result of lowered water tables, the implementation of a hose ban was brought into action in Co. Carlow at 8am on Friday, 6 July to midnight on Tuesday 31 July for all domestic public water supplies and commercial premises for non-commercial activities to save water supplies, however, with the continuous severity of hot conditions this ban was extended in Carlow until the 30th of Sept 2018. Ground movement led to 36 leaks in the pipe network due to contraction around pipe fittings.						■	■	■		
2018	February/ March	Storm Emma/ Beast from the East	Heavy snowfall and blizzard conditions were witnessed in Co. Carlow on the 1st, 2nd, and 3rd of March. A status orange followed by a status red alert was placed upon the County for parts of the storm and all schools and many businesses had to shut their doors throughout this extreme weather event as conditions were too treacherous to travel.				■	■					■
2017	21st October	Storm Brian	Aftermath of Storm Ophelia, Yellow wind warning was placed throughout the County				■						
2017	October	Storm Ophelia	At 12.26pm there was a wind elevation of 62m recorded in Oakpark in addition to strong gale forces up to 76km/hr and wind gusts of 117km/hr				■						
2016	January	Wettest Jan in 20 years	Persistent rain, particularly through the first half of the winter, resulted in new records for both monthly and seasonal rainfall accumulations widely across Ireland.									■	
2015	December	Storm Frank	Severe flooding in towns and villages in Kilkenny with Graiguenamanagh one of the worst affected. Rainfall of 60.0mm recorded. one family to evacuate their home in St. Mullins, Co. Carlow	■	■	■	■						
2015	17th November	Storm Barney	Gusts up to 78mph was recorded in the County of Carlow on the 17th of November. Impacts of wind and flooding was experienced in many towns within the County	■	■	■	■						
2014	12th-14th February	Storm Darwin	Oakpark in Co. Carlow recorded the county's highest gust at 68kt on Feb 12th at 15:26pm with rainfall of 17.1mm. Throughout this storm period in Carlow, a max windspeed reached 89kt and max gust reached 126kt recorded at Oakpark. Considerable damage and destruction was experienced county-wide.				■						
2010	November	Extreme Cold Spell	Similar conditions to 2009/2010 event			■						■	■
2009/ 2010	Winter	Winter Storms	2009/10 was the coldest winter in almost 50 years. Oak Park recording station measured a total of 188mm of rainfall. Recording a temperature of -12° C on the 7th of Jan 2010. The most rainfall to occur in a day was 20.1mm of rain on the 4th of Feb. The mean temp. was 2.6° C, a total of 49 days of rain, 50 days of air frost and 6 days of gale gusts was experienced.			■						■	■
2009	November	Flooding and heavy rainfall	In November 2009 Carlow experienced severe flooding in many parts of the County due to the banks of the Barrow bursting. Flooding occurred in Carlow and Leighlinbridge from 19th to 26th November which followed a flood event in Oct. 33 residential properties were affected by the flooding, impacting approx. 200 people. Six shops, five public houses, three restaurants, one garage and one leisure facility were flooded. Centaur Street, John Street, Kennedy Street, Barrow Track, Maryborough Street, Sleaty Street, and Pembroke Street were worst affected in addition to Newacre on the Athy Road and North of Carlow town experiencing flood impacts. The sewage pumping stations at Maryborough Street, Carlow Castle and Pembroke were also inundated with surface water	■		■							
2008	June-August	Flooding	Summer rainfall in Carlow in 2008 was above normal levels. Rainfall recorder located in Hackettstown measured 98.2 mm of rainfall in June, 170.9 mm in July and 138.5 mm in August giving a total of 407.6 mm of rain over 45 days. Centaur Street, Barrow Track, Maryborough Street, John Street, Cox's Lane, Pembroke and Kennedy Street were all affected	■	■	■							
2008	11th January	Flooding	Cox's Lane, Barrow Track, Centaur Street, Kennedy Street, John Street, Henry Street, Maryborough Street, Pembroke, Montgomery Street, areas around the boathouse and Carlow Weir experienced high flood water levels causing damage to properties	■									
2006	Summer	Heat wave	Warmest summer on record since 1995. Summer rainfall totals were below normal especially in the South-East of Ireland. Third highest records on the Poulter Index						■	■	■		
2002	November	Heavy Flooding	Severe flooding in eastern areas. major flood on the Slaney and the Slaney Catchment. Roads flooded at Rathvilly, Tullow, Rathglass and Clonegal. Multiple properties inundated at Tullow – worst flooding since 1965.	■	■	■						■	
2000	November	Severe Flooding	Centaur Street, Kennedy Street, John Street, Water Lane, Sleaty Street, Henry Street, Morris Lane, Barrow Track, and Seven Springs were the most affected areas. 28 residential properties and 15 commercial properties were flooded. 18 individuals had to be evacuated from six of these properties and one sewerage system pump was temporarily decommissioned. Roads were also closed for three days in Carlow town.	■	■	■							
1998	30th December	Flooding	Heavy rainfall caused the Burren to break its banks and Carlow town became flooded. Paupish Lane experienced major impacts with recorded depths of street flooding between 100 and 150 mm. Flood levels almost exceeded the lowest floor level in the area.	■		■							
1997	November	Extensive Flooding	Extensive flooding in the South-East of Ireland. River Slaney burst its banks and Tullow town experienced impacts to its infrastructure in addition to several damaged to agricultural crops and leaching of pollutants into waterways	■	■	■							
1996	5th January	Flooding	Flooding on 5th of Jan caused Carlow town to become impassable	■									
1995	Summer	Extreme Temperatures	1995 was the warmest summer on record. On the 2nd of August 1995 temperatures at Oak Park, Co. Carlow reached 31.5° C								■		
1995	28th January	Flooding	Heavy rain caused the River Barrow to break its banks. Centaur Street, Kennedy Street, John Street, Barrow Track, Pembroke Street, Burrin Street, John Street and Maryborough Street were worst affected in Carlow. The flood water reached a maximum depth of 1.15 m at John Street. Peak flows of 197.5 m^3/s and 215.9 m^3/s were recorded in the River Barrow, upstream and downstream	■		■							
1993	15th June	Flooding	Heavy rain caused the Barrow to break its banks. Flood water enter Kennedy street measuring to a depth of 2ft. Peak flows occurred at 170 m^3/s and 187.5 m^3/s upstream and downstream of the River Barrow.	■		■							
1991	24th December	Windstorm	Windstorm spread Countrywide mid Dec- early Jan 92' causing high levels of destruction countrywide				■						
1990	February	flooding	Co. Carlow experienced four days of flooding in mid-February 1990. The River Barrow broke its banks and passed through Kennedy Street. Peak flows of 182.5 m^3/s and 198.8 m^3/s were recorded in the River Barrow, upstream and downstream.	■									
1987	January	Heavy Snowfall	Carlow experienced approximately 6-10cm of snowfall					■					
1986	25th August	Hurricane Charley	Hurricane Charley brought extremely high gusts and rainfall to the South-Eastern counties of Ireland. High precipitation and wind levels resulted mostly in flood damages within the Carlow region	■	■	■	■						
1985	26th July	Thunderstorm	Widespread thunderstorm. Weather recorder at Oakpark measured 22mm of rainfall in 15mins and 28mm of rainfall in 30 mins on the 26th of July 1985			■							
1982	January	Heavy Snowfall	Carlow experienced approximately 16cm of snowfall					■					
1975/ 1976		Dry Period	Extreme dry period was experienced within the South East of Ireland between April 1975- Aug 1976, Carlow witnessed extreme hot conditions in August 1976						■		■		
1974	11th/12th January	Flooding	Flooding and high gusts caused trees to fall blocking roads and destruction to a number of mobile homes.		■	■	■						
1965	17th November	Flooding	This flood event was caused by extreme rainfall. Carlow town, Loughlinbridge and Tullow areas were most affected when the River Barrow burst its banks resulting in some roads becoming impassable in addition to damaging approx. 60 properties.	■	■	■							
1963	January	Severe Cold Spell	Low temperatures recorded										■
1961	September	Hurricane Debbie	wind gusts >100mph causing damage to the western half of the country with 11 no. deaths associated.	■	■	■	■						
1954	December	Flooding	Widespread flooding in the east of the country	■	■	■							
1947	17th March	Flooding	Severe flooding followed a rapid thawing of snow and ice event in addition to heavy rainfall. Carlow town and Loughlinbridge were most affected and flood water remained for approx. four days. Centaur street experienced a depth of 1.35 m's of water on its street and peak flows within the River Barrow reached up to 240 m^3/s upstream of the Burren tributary and 260 m^3/s downstream of the tributary.	■	■	■							■

Appendix D Characterisation of Climate Hazards, Impacts, Exposures, Vulnerabilities and Assessment

Hazard Event:	**River Flood**
Frequency of Occurrence:	Frequent
Description of the Hazard Event: (Including relevant meteorological / climatological conditions and locations affected)	Rivers exceeding the capacity of their river banks. Bursting of river banks. Riverside infrastructure particularly affected.

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																	Impact Score
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Damage to infrastructure	Flood water affecting built environment. Can lead to closure of facilities	LA buildings	Physical	Use of material Built Heritage Fixed or manual flood defences Flooded outfalls Structural loading	Moderate	None	Negligible	None	None	None	Minor	None	Minor	None	Negligible	Minor	None	None	None	None	None	None	0.61
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to rivers																		
			Socioeconomic	-																		
		Roads & Bridges	Physical	Use of material Built Heritage Structural loading	None	None	None	None	None	None	Negligible	None	Minor	None	None	None	None	None	None	Moderate	None	None	0.33
			Environmental	Proximity to rivers																		
			Socioeconomic	-																		
		Railway	Physical	-	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	Moderate	None	None	0.22
			Environmental	Proximity to rivers																		
			Socioeconomic	-																		
		Housing	Physical	Use of material Built Heritage Fixed or manual flood defences Flooded outfalls Structural loading	None	None	None	Negligible	None	None	Minor	None	None	Moderate	Negligible	None	None	None	None	None	None	None	0.39
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to rivers																		
			Socioeconomic	-																		
		Construction sites	Physical	Security of materials Silt netting	None	None	Minor	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to rivers																		
			Socioeconomic	-																		
		Commerce	Physical	Storage of stock/ equipment	Negligible	None	Minor	None	None	None	Negligible	None	None	None	None	Minor	None	None	None	None	Minor	None	0.44
			Environmental	Proximity to rivers																		
			Socioeconomic	-																		
		Agricultural land	Physical	Efficiency of drainage network Flooded outfalls	None	None	Minor	None	None	Negligible	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental	Proximity to rivers																		
			Socioeconomic	-																		
		Drainage networks	Physical	Capacity Build up of silt	None	None	None	None	None	Minor	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	-																		
			Socioeconomic	-																		
		Land use suitability	Physical	Adequacy of drainage network	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	Moderate	None	None	None	0.22
			Environmental	Proximity to rivers																		
			Socioeconomic	-																		
		Power supply	Physical	Fixed or manual flood defences Flooded outfalls Structural loading Backup generator availability	Negligible	Negligible	Major	Negligible	Minor	Negligible	Minor	Negligible	Negligible	Negligible	Minor	Moderate	Negligible	Negligible	Negligible	Moderate	Negligible	Moderate	1.67
			Environmental	Ground elevation and gradient relative to surrounding area Proximity to rivers																		
			Socioeconomic	-																		
Damage to environment	Loss of biodiversity	SAC/SPA/natural habitats	Physical	Flora sensitivity to saturation Anchorage of flora	None	None	None	None	None	Major	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.28
			Environmental	Ground elevation and gradient relative to surrounding area Proximity to rivers																		
			Socioeconomic	-																		
Damage to riverside amenities	Damage to amenities on riverbanks, leading to closure for public safety	Walkways and trails	Physical	-	None	None	None	Minor	None	None	Negligible	None	None	None	None	None	Minor	None	None	None	Minor	None	0.39
			Environmental	Ground elevation and gradient relative to surrounding area Proximity to rivers																		
			Socioeconomic	-																		
Unusable roads	Roads will become inundated with water and become inaccessible	Road network	Physical	Efficiency of drainage network Flooded outfalls	None	None	Negligible	Negligible	Moderate	None	Negligible	Negligible	None	None	None	None	Negligible	None	None	Moderate	Negligible	None	0.67
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to rivers																		
			Socioeconomic	-																		
		Pathways/ cycle lanes	Physical	Drainage network	None	None	None	Minor	None	None	Negligible	None	None	None	None	None	Minor	None	None	Moderate	Negligible	None	0.50
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to rivers																		
			Socioeconomic	-																		
		General public	Physical	-	None	None	None	None	None	None	Negligible	None	None	None	None	None	Negligible	None	None	None	Minor	None	0.22
			Environmental	Road congestion																		
			Socioeconomic	Exposure to warnings/ alerts																		
		Emergency responders	Physical	-	None	None	Minor	None	Major	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.39
			Environmental	Road congestion																		
			Socioeconomic	Reliance on TII for alerts on National roads Extended workload and overtime leading to burnout and availability of monitoring staff																		

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																	
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	Impact Score
Reduced water quality	Foreign substances entering water systems. Boil water notices issued in some cases	Water bodies	Physical	Sewage overflow inputs into water bodies Water turbidity Combined foul and surface system	None	None	Negligible	None	None	Major	Negligible	None	None	None	None	None	None	None	None	None	None	Major	0.56
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to rivers																			
			Socioeconomic	-																			
		Water supply distribution	Physical	Back up generator availability	None	None	Negligible	Negligible	None	None	Minor	None	None	Negligible	Negligible	None	None	None	None	None	None	Major	0.56
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to rivers																			
			Socioeconomic	Extended workload and overtime leading to burnout and availability of monitoring staff Resoonsibility (Irish Water)																			
Inundated wastewater treatment systems	Private systems located in poor drainage areas and/or flood zones become inundated	Wastewater infrastructure	Physical	Capacity and fullness of septic tanks	None	None	None	Minor	None	None	Minor	None	None	None	None	None	None	None	None	None	None	Major	0.44
			Environmental	Water table level Proximity to rivers																			
			Socioeconomic	-																			
Temporary housing	Relocation of homeless and residents of flooded properties	General public	Physical	-	None	None	None	None	None	None	Negligible	Negligible	None	Moderate	Minor	None	Negligible	None	None	None	Minor	None	0.56
			Environmental	Proximity to rivers																			
			Socioeconomic	Population age Population constitution Housing availability																			
		LA staff	Physical	-	None	None	None	None	None	None	Negligible	Negligible	None	Moderate	Minor	None	None	None	None	None	Negligible	None	0.44
			Environmental	Proximity to rivers																			
			Socioeconomic	Population age Population constitution Housing availability																			
		Homeless	Physical	-	None	None	None	None	None	None	Negligible	Negligible	None	Moderate	Minor	None	None	None	None	None	None	None	0.39
			Environmental	Proximity to rivers																			
			Socioeconomic	Population age Population constitution Housing availability																			
Health and Safety risks	Drowning/ presence of submerged hazards leading to injury or death	General public	Physical	-	None	None	Minor	None	Minor	None	Negligible	None	None	None	None	None	Negligible	None	None	None	Minor	None	0.44
			Environmental	Proximity to rivers																			
			Socioeconomic	Human desire to watch the event from an unsafe location Population age Population constitution Exposure to warnings/ alerts																			
		LA staff	Physical	-	None	None	Minor	None	Minor	None	Negligible	Negligible	None	None	None	None	None	Minor	None	None	Negligible	None	0.50
			Environmental	Proximity to rivers																			
			Socioeconomic	Population age Population constitution																			
		Homeless	Physical	-	None	None	None	None	Minor	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Proximity to rivers																			
			Socioeconomic	Population age Population constitution																			
Cancellation/ postponing of cultural events	Adverse weather disrupting ability to hold a cultural event	Cultural events	Physical	-	None	Moderate	Negligible	None	None	None	Negligible	None	None	None	None	None	Negligible	None	None	None	Minor	None	0.44
			Environmental	Proximity to rivers																			
			Socioeconomic	-																			

Hazard Event:	**Extreme Precipitation**
Frequency of Occurrence:	Very Frequent
Description of the Hazard Event: (including relevant meteorological / climatological conditions and locations affected)	An unusually large volume of rainfall in a short period of time. Red Warning 70mm or greater in 24 hours. Orange Warning 50-70mm in 24 hours. Yellow Warning 30-50mm in 24 hours.

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																	Impact Score
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Flooding	Excessive rainfall resulting in flooding, causing damage. Can lead to closure of facilities	LA buildings	Physical	Use of material Built Heritage Fixed or manual flood defences Flooded outfalls Structural loading	Moderate	None	Negligible	None	None	None	Minor	None	Minor	None	Negligible	Moderate	None	None	None	None	None	None	0.67
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
		Roads & Bridges	Physical	Use of material Built Heritage Adequacy of drainage systems	None	None	None	None	None	None	Negligible	None	Minor	None	None	None	None	None	None	Moderate	None	None	0.33
			Environmental	Faster rate of deterioration in roads due to prolonged exposure of road surfaces to flooding																		
			Socioeconomic	-																		
		Housing	Physical	Use of material Built Heritage Fixed or manual flood defences Flooded outfalls Structural loading	None	None	None	Negligible	None	None	Minor	None	None	Moderate	Negligible	None	None	None	None	None	None	None	0.39
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
		Construction sites	Physical	Security of materials Silt netting	None	None	Minor	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
		Commerce	Physical	Storage of stock/ equipment	Negligible	None	Minor	None	None	None	Negligible	None	None	None	None	Minor	None	None	None	None	Minor	None	0.44
			Environmental	Proximity to urban environment																		
			Socioeconomic	-																		
		Drainage networks	Physical	Capacity Build up of silt	None	None	None	None	None	Minor	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	-																		
			Socioeconomic	-																		
		SAC/SPA/natural habitats	Physical	Flora sensitivity to saturation Anchorage of flora	None	None	Minor	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.33
			Environmental	Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
		Agricultural land	Physical	Efficiency of drainage network Flooded outfalls	None	None	Minor	None	None	Negligible	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental	Proximity to urban environment																		
			Socioeconomic	-																		
		Land use suitability	Physical	Adequacy of drainage network	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	Moderate	None	None	None	0.22
			Environmental	Proximity to urban environment																		
			Socioeconomic	-																		
		Amenities	Physical	Equipment security Adequacy of drainage network	None	Minor	None	Minor	None	None	Negligible	None	None	None	None	None	Moderate	None	None	None	Moderate	None	0.61
			Environmental	Proximity to urban environment																		
			Socioeconomic	-																		
Unusable roads	Roads will become inundated with water and become inaccessible	Road network	Physical	Efficiency of drainage network	None	None	None	Minor	Minor	None	Negligible	None	None	None	None	None	Negligible	None	Negligible	Moderate	Negligible	None	0.61
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
		Pathways/ cycle lanes	Physical	-	None	None	None	Minor	None	None	Negligible	None	None	None	None	None	Minor	None	None	Moderate	Minor	None	0.56
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
		General public	Physical	-	None	Negligible	Minor	Minor	Minor	None	Negligible	None	None	None	None	None	Negligible	None	None	None	Minor	None	0.61
			Environmental	Road congestion																		
			Socioeconomic	Exposure to warnings/ alerts																		
		Emergency responders	Physical	-	None	None	Moderate	Minor	Moderate	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.50
			Environmental	Road congestion																		
			Socioeconomic	Reliance on TII for alerts on National roads Extended workload and overtime leading to burnout and availability of monitoring staff																		
Reduced water quality	Washed out nutrients/chemicals from surface run off entering water bodies. Boil water notices issued in some cases	Water bodies	Physical	Sewage overflow inputs into water bodies Gradient of ground Water turbidity Capacity	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	Major	0.44
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
		Water supply distribution	Physical	Increase in peak flows Back up generator availability	None	None	None	Minor	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	Major	0.39
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	Extended workload and overtime leading to burnout and availability of monitoring staff Responsibility (Irish Water)																		
Inundated wastewater treatment systems	Private systems located in poor drainage areas and/or flood zones become inundated	Wastewater infrastructure	Physical	Capacity and fullness of septic tanks	None	None	None	Minor	None	None	Negligible	None	None	None	None	None	None	None	None	None	Major	0.39
			Environmental	Water table level Proximity to urban environment																		
			Socioeconomic	-																		

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																		
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	Impact Score
Health and Safety risks	Heavy rain affects safe travel and poses a risk of injury from uncertain footing	General public	Physical	-	None	Negligible	Minor	Minor	Minor	None	Negligible	None	None	None	None	None	Negligible	None	None	None	None	None	0.50
			Environmental	Available cover Proximity to urban environments Adequacy of drainage systems																			
			Socioeconomic	Population age Population constitution																			
		Council staff	Physical	-	None	None	Moderate	None	Moderate	None	Negligible	Negligible	None	None	None	None	None	Minor	None	None	None	None	0.56
			Environmental	Available cover Proximity to urban environments Adequacy of drainage systems																			
			Socioeconomic	Population age Population constitution																			
		Outdoor workers	Physical	Transport method used	None	None	Minor	Minor	Minor	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.39
			Environmental	Available cover Proximity to urban environments Adequacy of drainage systems																			
			Socioeconomic	Population age Population constitution																			
Land erosion	Rainfall causing ground saturation, weakening ground strength	Saturated cliffs	Physical	Soil properties	None	None	None	Minor	None	Moderate	Negligible	None	None	None	None	None	None	None	None	Negligible	None	None	None	0.39
			Environmental	Ground elevation and gradient relative to surrounding area Proximity to urban environment																			
			Socioeconomic	-																			
Erosion of structures	Chemical reaction dissolving structures/ scour	LA buildings	Physical	Use of material Built Heritage	None	None	None	None	None	None	Negligible	None	Minor	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	-																			
			Socioeconomic	-																			
		Road network	Physical	Use of material Built Heritage	None	None	Negligible	None	None	None	Negligible	None	None	None	None	None	None	None	None	Moderate	None	None	0.28
			Environmental	-																			
			Socioeconomic	-																			
		Housing	Physical	Use of material Built Heritage	None	None	None	None	None	None	Negligible	None	None	Minor	None	None	None	None	None	None	None	None	None	0.17
			Environmental	-																			
			Socioeconomic	-																			
Cancellation/ postponing of cultural events	Adverse weather disrupting ability to hold a cultural event	Cultural events	Physical	Available cover	None	Moderate	Negligible	None	None	None	Negligible	None	None	None	None	None	Negligible	None	None	None	Minor	None	0.44
			Environmental	Proximity to urban areas																			
			Socioeconomic	-																			

Hazard Event:	**Severe Windstorm**
Frequency of Occurrence:	Very frequent
Description of the Hazard Event: (Including relevant meteorological / climatological conditions and locations affected)	Red Warning indicating mean gusts >80km/h. Gusts in excess of 130km/h Orange Warning indicating mean gusts of 65-80km/h. Gusts ranging between 110-130km/h Yellow Warning indicating mean gusts of 50-65km/h. Gusts ranging between 90-110km/h

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																		Impact Score
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Damage to infrastructure	Wind causing damage to infrastructure. Can lead to closure of facilities	LA buildings	Physical	Use of material Built Heritage Structural loading Building heights	Negligible	None	Moderate	Minor	None	None	Minor	None	Moderate	Minor	Negligible	None	None	Minor	Negligible	None	Negligible	None	1.00
			Environmental	Proximity to vegetation Wind tunnels in urban environments																			
			Socioeconomic	-																			
		Bridges	Physical	Use of material Built Heritage Structural loading	None	None	None	None	None	None	Negligible	None	Moderate	None	None	None	None	None	None	Moderate	None	None	0.39
			Environmental	-																			
			Socioeconomic	-																			
		Housing	Physical	Use of material Built Heritage Structural loading Building heights	None	None	None	Minor	Minor	None	Minor	None	None	Minor	None	None	None	None	None	None	None	None	0.44
			Environmental	Proximity to vegetation Wind tunnels in urban environments																			
			Socioeconomic	-																			
		Commerce	Physical	-	Negligible	None	Moderate	None	None	None	Negligible	Negligible	None	None	None	Negligible	None	Negligible	None	None	Moderate	None	0.61
			Environmental	Proximity to vegetation Wind tunnels in urban environments																			
			Socioeconomic	Nature of business																			
		Telemetry	Physical	-	None	None	Moderate	Moderate	Moderate	None	Negligible	Negligible	None	None	Negligible	Moderate	Minor	Negligible	None	Minor	Minor	Minor	1.33
			Environmental	Proximity to vegetation																			
			Socioeconomic	-																			
		Water abstraction and wastewater infrastructure	Physical	Integrity of treatment plant infrastructure	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	Moderate	0.22
			Environmental	Proximity to vegetation																			
			Socioeconomic	-																			
		Amenities	Physical	Equipment security Available shelter Adequacy of drainage network	None	Minor	None	Minor	None	None	Negligible	None	None	None	None	None	Moderate	None	None	None	Moderate	None	0.61
			Environmental	Level of exposure to wind																			
			Socioeconomic	-																			
Damage to environment	Loss of biodiversity	SAC/SPA/natural habitats	Physical	Integrity of habitats Available shelter	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	Minor	None	0.33
			Environmental	Level of exposure to wind																			
			Socioeconomic	-																			
Loose debris/material	Debris picked up by wind creating blockages and causing damage to infrastructure and population	LA buildings	Physical	Use of material Built Heritage	Negligible	None	Moderate	Minor	None	None	Negligible	None	Minor	Minor	None	None	None	Minor	Negligible	None	Negligible	None	0.83
			Environmental	Proximity to vegetation Wind tunnels in urban environments																			
			Socioeconomic	-																			
		Bridges	Physical	Use of material Built Heritage	None	None	None	None	Minor	None	Negligible	None	Minor	None	None	None	None	None	None	Moderate	Minor	None	0.56
			Environmental	Proximity to vegetation Wind tunnels in urban environments																			
			Socioeconomic	-																			
		Construction sites	Physical	Use of material Security of materials Potential to compromise scaffolding	Negligible	None	Moderate	Minor	None	None	Negligible	None	None	Minor	None	None	None	None	Moderate	None	None	None	0.67
			Environmental	Proximity to vegetation Wind tunnels in urban environments																			
			Socioeconomic	-																			
		Derelict buildings	Physical	Use of material Built Heritage	None	None	None	Minor	Minor	None	Negligible	None	None	None	None	None	None	None	Minor	None	None	None	0.39
			Environmental	Proximity to vegetation Wind tunnels in urban environments																			
			Socioeconomic	-																			
		Water treatment plants	Physical	Contamination prevention/ mitigation measures	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	Moderate	0.22
			Environmental	Proximity to vegetation																			
			Socioeconomic	-																			
		Water bodies	Physical	Size of water body Contamination prevention/ mitigation measures	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	Moderate	0.39
			Environmental	Proximity to vegetation																			
			Socioeconomic	-																			
Health and Safety risks	High winds affect safe travel and poses a risk of injury	General public	Physical	-	None	Negligible	Minor	Minor	Moderate	None	Negligible	None	None	None	None	None	Negligible	None	None	None	None	None	0.56
			Environmental	Available shelter Wind tunnels in urban environments																			
			Socioeconomic	Human desire to watch the event from an unsafe location Population age Population constitution Homeless																			
		Council staff	Physical	-	None	None	Moderate	None	Moderate	None	Negligible	Negligible	None	None	None	None	None	Minor	None	None	None	None	0.56
			Environmental	Available shelter Wind tunnels in urban environments																			
			Socioeconomic	Population age Population constitution																			
		Outdoor workers	Physical	Transport method used	None	None	Minor	Minor	Minor	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.39
			Environmental	Available shelter Wind tunnels in urban environments																			
			Socioeconomic	Population age Population constitution																			

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																		Impact Score
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Power supply cuts	Damage to powerlines leading to loss of power to urban and regional centres	Commerce	Physical	Presence of overhead lines Backup generator availability	Negligible	None	Moderate	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	Moderate	None	0.44
			Environmental	Proximity to vegetation																			
			Socioeconomic	-																			
		LA buildings	Physical	Presence of overhead lines Backup generator availability	Negligible	None	Moderate	Minor	None	None	Negligible	Negligible	Moderate	Minor	None	Minor	None	Minor	Minor	None	Moderate	None	1.22
			Environmental	Proximity to vegetation																			
			Socioeconomic	-																			
		Housing	Physical	Presence of overhead lines Backup generator availability	None	None	None	Minor	Minor	None	Negligible	None	None	Minor	None	None	None	None	None	None	None	None	0.39
			Environmental	Proximity to vegetation																			
			Socioeconomic	Population age Population constitution																			
		Hospital/Health Centres	Physical	Presence of overhead lines Backup generator availability	Negligible	None	None	Minor	Moderate	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.39
			Environmental	Proximity to vegetation																			
			Socioeconomic	-																			
		Communication/ servers	Physical	Presence of overhead lines Backup generator availability	Minor	Negligible	Minor	Minor	Major	Minor	Minor	Minor	Minor	Minor	Minor	Moderate	Negligible	Minor	Minor	Moderate	Moderate	Minor	2.17
			Environmental	Proximity to vegetation																			
			Socioeconomic	-																			
		Water and wastewater treatment plants	Physical	Presence of overhead lines Backup generator availability Emergency supply storage Overflow from wastewater systems due to power outage	None	None	None	None	Minor	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	Moderate	0.33
			Environmental	Proximity to vegetation																			
			Socioeconomic	-																			
Falling trees/ branches	Wind destroying trees and carrying material leading to a variety of disruption to services	Outdoor workers	Physical	Personal Protective Equipment	None	Negligible	Moderate	Minor	Minor	None	Negligible	None	None	None	Minor	None	None	None	None	None	None	None	None	0.61
			Environmental	Influenced by time of year Proximity to/ volume of vegetation Available cover																			
			Socioeconomic	Population age Population constitution																			
		Emergency services	Physical	Personal Protective Equipment	None	Negligible	Moderate	Minor	Minor	None	Negligible	None	None	None	Minor	None	None	None	None	None	None	None	None	0.61
			Environmental	Influenced by time of year Proximity to/ volume of vegetation Available shelter																			
			Socioeconomic	Population age Population constitution																			
		Parks	Physical	Soil properties	None	None	None	Minor	None	Moderate	Negligible	None	None	None	None	None	Minor	None	None	None	Moderate	None	0.61
			Environmental	Influenced by time of year Proximity to/ volume of vegetation																			
			Socioeconomic	-																			
		Transport infrastructure including roads, rail, and pathways	Physical	Use of material Built Heritage	None	None	None	Minor	Minor	None	Negligible	None	None	None	None	None	Negligible	None	Negligible	Moderate	Minor	None	0.67
			Environmental	Influenced by time of year Proximity to/ volume of vegetation																			
			Socioeconomic	Remote working Alternate transport methods Reliance on TII for alerts on National roads																			
		Water and wastewater treatment plants	Physical	Debris management measures	None	None	None	None	Minor	None	Negligible	None	None	None	None	None	None	None	None	None	None	Moderate	0.33
			Environmental	Influenced by time of year Proximity to/ volume of vegetation																			
			Socioeconomic	Extended workload and overtime leading to burnout and availability of monitoring staff																			
Cancellation/ postponing of cultural events	Adverse weather disrupting ability to hold a cultural event	Cultural events	Physical	Available shelter	None	Major	Negligible	Minor	None	None	Negligible	None	None	None	None	None	None	None	None	None	Minor	None	0.56
			Environmental	Level of exposure to wind																			
			Socioeconomic	-																			

Hazard Event:	**Pluvial Flood**
Frequency of Occurrence:	Common
Description of the Hazard Event: (Including relevant meteorological / climatological conditions and locations affected)	Period of wet weather resulting in saturated soils. Heavy precipitation levels causes surface water flooding. Precipitation levels exceeding historic levels.

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																	Impact Score
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Damage to infrastructure	Flood water affecting built environment. Can lead to closure of facilities	LA buildings	Physical	Use of material Built Heritage Adequacy of drainage network Flooded outfalls Structural loading	Moderate	None	Negligible	None	None	None	Minor	None	Minor	None	Negligible	Moderate	None	None	None	None	None	None	0.67
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to vegetation																		
			Socioeconomic	-																		
		Roads & Bridges	Physical	Use of material Built Heritage Adequacy of drainage network Structural loading	None	None	None	None	None	None	Negligible	None	Minor	None	None	None	None	None	None	Moderate	None	None	0.33
			Environmental	Proximity to vegetation																		
			Socioeconomic	-																		
		Housing	Physical	Use of material Built Heritage Fixed or manual flood defences Flooded outfalls Structural loading	None	None	None	Negligible	None	None	Minor	None	None	Moderate	Negligible	None	None	None	None	None	None	None	0.39
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to vegetation																		
			Socioeconomic	-																		
		Construction sites	Physical	Security of materials Silt netting	None	None	Minor	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to vegetation																		
			Socioeconomic	-																		
		Commerce	Physical	Storage of stock/ equipment	Negligible	None	Minor	None	None	None	Negligible	None	None	None	None	Minor	None	None	None	None	Minor	None	0.44
			Environmental	Proximity to urban environment																		
			Socioeconomic	-																		
		Drainage networks	Physical	Capacity Build up of silt/leaves	None	None	None	None	None	Minor	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Proximity to vegetation																		
			Socioeconomic	-																		
		Agricultural land	Physical	Adequacy of drainage network Flooded outfalls	None	None	Minor	None	None	Negligible	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental	Proximity to urban environment																		
			Socioeconomic	-																		
		Power supply	Physical	Fixed or manual flood defences Flooded outfalls Structural loading Backup generators	Negligible	Negligible	Major	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Minor	Moderate	Negligible	Negligible	Negligible	Moderate	Negligible	Moderate	1.61
			Environmental	Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
Damage to environment	Loss of biodiversity	SAC/SPA/natural habitats	Physical	Flora sensitivity to saturation Anchorage of flora	None	None	None	None	None	Major	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.28
			Environmental	Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
Unusable roads	Roads will become inundated with water and become inaccessible	Road network	Physical	Efficiency of drainage network Flooded outfalls	None	None	Negligible	Negligible	Moderate	None	Negligible	Negligible	None	None	None	None	Negligible	None	None	Moderate	Negligible	None	0.67
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
		Pathways/ cycle lanes	Physical	Drainage network	None	None	None	Minor	None	None	Negligible	None	None	None	None	None	Minor	None	None	Moderate	Negligible	None	0.50
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	-																		
		General public	Physical	-	None	None	None	None	None	None	Negligible	None	None	None	None	None	Negligible	None	None	None	Minor	None	0.22
			Environmental	Road congestion																		
			Socioeconomic	Exposure to warnings/ alerts																		
		Emergency responders	Physical	-	None	None	Minor	None	Major	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.39
			Environmental	Road congestion																		
			Socioeconomic	Reliance on TII for alerts on National roads Extended workload and overtime leading to burnout and availability of monitoring staff																		
Reduced water quality	Vegetation debris or leachate from surface run off entering water systems. Boil water notices issued in some cases	Water bodies	Physical	Sewage overflow inputs into water bodies Water turbidity Combined foul and surface system	None	None	Negligible	None	None	Major	Negligible	None	None	None	None	None	None	None	None	None	None	Major	0.56
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment Proximity to agricultural land																		
			Socioeconomic	-																		
		Water supply	Physical	-	None	None	Negligible	Negligible	None	None	Negligible	None	None	Negligible	Negligible	None	None	None	None	None	None	Major	0.50
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																		
			Socioeconomic	Extended workload and overtime leading to burnout and availability of monitoring staff Responsibility (Irish Water)																		
Inundated wastewater treatment systems	Private systems located in poor drainage areas and/or flood zones become inundated	Wastewater infrastructure	Physical	Capacity and fullness of septic tanks	None	None	None	Minor	None	None	Minor	None	None	None	None	None	None	None	None	None	None	Major	0.44
			Environmental	Water table level Proximity to urban environment																		
			Socioeconomic	-																		

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																	
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	Impact Score
Temporary housing	Relocation of homeless and residents of flooded properties	General public	Physical	-	None	None	None	None	None	None	Negligible	Negligible	None	Moderate	Minor	None	Negligible	None	None	None	Minor	None	0.56
			Environmental	Proximity to urban environment																		
			Socioeconomic	Population age Population constitution Housing availability																		
		LA staff	Physical	-	None	None	None	None	None	None	Negligible	Negligible	None	Moderate	Minor	None	None	None	None	None	Negligible	None	0.44
			Environmental	Proximity to urban environment																		
			Socioeconomic	Population age Population constitution Housing availability																		
		Homeless	Physical	-	None	None	None	None	None	None	Negligible	Negligible	None	Moderate	Minor	None	None	None	None	None	None	None	0.39
			Environmental	Proximity to urban environment																		
			Socioeconomic	Population age Population constitution Housing availability																		
Health and Safety risks	Drowning/ presence of submerged hazards leading to injury or death	General public	Physical	-	None	None	Minor	None	Minor	None	Negligible	None	None	None	None	None	Negligible	None	None	None	Minor	None	0.44
			Environmental	Proximity to urban environment																		
			Socioeconomic	Human desire to watch the event from an unsafe location Population age Population constitution Exposure to warnings/ alerts																		
		LA staff	Physical	-	None	None	Minor	None	Minor	None	Negligible	Negligible	None	None	None	None	None	Minor	None	None	Negligible	None	0.50
			Environmental	Proximity to urban environment																		
			Socioeconomic	Population age Population constitution																		
		Homeless	Physical	-	None	None	None	None	Minor	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Proximity to urban environment																		
			Socioeconomic	Population age Population constitution																		
Cancellation/ postponing of cultural events	Adverse weather disrupting ability to hold a cultural event	Cultural events	Physical	-	None	Moderate	Negligible	None	None	None	Negligible	None	None	None	None	None	Negligible	None	None	None	Minor	None	0.44
			Environmental	Proximity to urban environment																		
			Socioeconomic	-																		

Hazard Event:	**Heavy Snowfall**
Frequency of Occurrence:	Common
Description of the Hazard Event: (Including relevant meteorological / climatological conditions and locations affected)	Red warning: significant falls of snow likely to cause accumulations of 8cm or greater below 250m above mean sea level. Orange warning: significant falls of snow likely to cause accumulations of 3cm or greater below 250m above mean sea level. Yellow warning: scattered snow showers giving accumulations of less than 3cm below 250m above mean sea level.

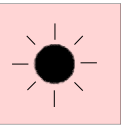
Hazard Impact	Impact Description:	Vulnerability			Service Areas: Level of Disruption																	Impact Score
		Exposure	Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Damage to infrastructure	Heavy build-up of snow exceeding structural limits	LA Buildings	Physical	Use of material Built Heritage Structural loading Time to thaw	Minor	None	Minor	Minor	None	None	Minor	Negligible	Minor	None	None	None	None	Minor	None	None	Minor	None	0.83
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	-																		
		Housing	Physical	Use of material Built Heritage Structural loading Time to thaw	None	None	None	Minor	Minor	None	Minor	None	None	Minor	None	None	None	None	None	None	None	None	0.44
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	-																		
		Bridges	Physical	Use of material Built Heritage Structural loading Time to thaw	None	None	Negligible	None	Negligible	None	Negligible	None	Negligible	None	None	None	None	None	None	Moderate	None	None	0.39
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	-																		
		Power supply	Physical	Presence of overhead lines Time to thaw	Negligible	Negligible	Major	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Minor	Moderate	Negligible	Negligible	Negligible	Moderate	Negligible	Moderate	2.28
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	-																		
		Water and wastewater treatment plants	Physical	Use of material Built Heritage Structural loading Back up generator availability Time to thaw	None	None	Minor	None	Minor	None	Negligible	None	None	None	Minor	None	None	None	None	None	Negligible	Major	
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	-																		
		Telemetry	Physical	Structural loading Backup generators Time to thaw	Negligible	Negligible	Major	Negligible	Minor	Negligible	Minor	Negligible	Negligible	None	Minor	Moderate	Negligible	Negligible	Negligible	Moderate	Negligible	Moderate	1.61
			Environmental	Proximity to vegetation																		
			Socioeconomic	-																		
Damage to environment	Erosion due to freeze-thaw action	SAC/SPA/natural habitats	Physical	Cliff stability	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	Negligible	None	None	None	Negligible	None	0.33
			Environmental	Elevation relative to sea level																		
			Socioeconomic	-																		
Disruption to infrastructure/ facilities	Snow build-up disrupting transport networks, building access, amenity access, and water treatment processes	Transport infrastructure	Physical	Time to thaw	None	None	Moderate	Minor	Major	None	Negligible	None	None	None	Negligible	None	Minor	None	None	Moderate	Moderate	None	1.06
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	Snow removing measures High impact for people who reside in isolated locations who are cut off with no access to services																		
		Buildings	Physical	Time to thaw	None	None	Minor	Minor	None	None	Negligible	Negligible	None	None	None	None	Negligible	Minor	None	None	Minor	None	0.61
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	-																		
		Amenities	Physical	Time to thaw	None	None	None	Moderate	None	None	Negligible	None	None	None	Negligible	None	Minor	Moderate	None	None	Minor	None	0.67
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	Snow removing measures																		
		Water and wastewater treatment systems	Physical	Time to thaw	None	None	Negligible	None	Minor	None	Minor	None	None	None	Minor	None	None	None	None	None	Negligible	Major	0.67
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	Snow removing measures																		
		Schools	Physical	Time to thaw	None	None	Minor	Moderate	None	None	Negligible	None	None	None	Negligible	None	None	None	None	None	None	None	0.39
			Environmental	Ground elevation relative to sea level																		
			Socioeconomic	Snow removing measures																		
Health and Safety risks	Heavy snowfall affects safe travel and poses a risk of injury	General public	Physical	-	None	Negligible	Minor	Minor	Minor	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.44
			Environmental	Available cover Proximity to urban environments																		
			Socioeconomic	Population age Population constitution																		
		Council staff	Physical	-	None	None	Moderate	None	Moderate	None	Negligible	Negligible	None	None	None	None	None	Minor	None	None	None	None	0.56
			Environmental	Available cover Proximity to urban environments																		
			Socioeconomic	Population age Population constitution Training required to operate vehicles/equipment to aid in emergency events																		
		Outdoor workers	Physical	Transport method used	None	None	Minor	Minor	Moderate	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.44
			Environmental	Available cover Proximity to urban environments																		
			Socioeconomic	Population age Population constitution Training required to operate vehicles/equipment to aid in emergency events																		
Minor flooding issues	Fast thawing of large amounts of snow can lead to excessive amounts of surface run off	Drainage network	Physical	Capacity of drainage network	None	None	Negligible	None	None	None	Negligible	None	None	None	None	None	None	None	None	Minor	None	None	0.22
			Environmental	-																		
			Socioeconomic	-																		
Reduced air quality	Heavy snow leads to less active travel and the need for more heat in buildings, increasing burning of fossil fuels	Air	Physical	Level of insulation of buildings	None	None	None	None	None	Minor	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Proximity to urban environment																		
			Socioeconomic	-																		
		People	Physical	-	None	None	None	Negligible	Negligible	None	Negligible	None	None	None	Negligible	None	None	None	None	None	None	None	None	0.22
			Environmental	-																		
			Socioeconomic	Population age Population constitution																		
Frostbite	Exposure to snow can lead to frostbite	People	Physical	-	None	None	Minor	Minor	Moderate	None	Negligible	None	None	None	Minor	None	Minor	None	None	None	Minor	None	0.78
			Environmental	Proximity to urban environment Available cover																		
			Socioeconomic	Human desire to watch the event from an unsafe location Population age Population constitution Homeless																		

Hazard Event:	**Heatwave**
Frequency of Occurrence:	Common
Description of the Hazard Event: (Including relevant meteorological / climatological conditions and locations affected)	Record high temperatures with temperatures exceeding 30°C over a number of consecutive days. Urban areas particularly affected.

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																	Impact Score
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Hot and uncomfortable working conditions	High temperatures in homes and office causing discomfort	Outdoor workers	Physical	-	None	None	Moderate	None	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	Minor	0.50
			Environmental	Limited access to green areas/ areas of shade Inadequate access to water/ sun screen/ cooling apparatus																		
			Socioeconomic	Population age Population constitution																		
		Indoor workers	Physical	-	None	None	Moderate	None	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	Minor	0.50
			Environmental	Limited access to green areas/ areas of shade Inadequate access to water/ cooling apparatus																		
			Socioeconomic	Population age Population constitution																		
Risk of fires	Wildfires or domestic fires are easily started in heatwaves due to the dryness of the environment	People	Physical	Campfires going out of control BBQ's in urban areas gives of stray flame	None	None	None	None	Moderate	None	Negligible	None	None	None	None	None	Negligible	None	None	None	None	None	0.28
			Environmental	Proximity to fire Exposure to fire																		
			Socioeconomic	Population age Population constitution																		
		Environment	Physical	-	None	None	None	None	Moderate	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.39
			Environmental	Proximity to fire Upland areas and gorse areas typically affected Areas of conservation Biodiversity present																		
			Socioeconomic	-																		
		LA Buildings	Physical	Structural integrity Fire proofing of buildings Built Heritage	Negligible	None	Minor	None	Moderate	None	Negligible	None	Minor	None	None	None	None	Minor	None	None	None	None	0.61
			Environmental	Proximity to fire																		
			Socioeconomic	-																		
		Housing	Physical	Structural integrity Fire proofing of buildings Built Heritage	None	None	None	Minor	Moderate	None	Negligible	None	None	Minor	None	None	None	None	None	None	None	None	0.44
			Environmental	Proximity to fire																		
			Socioeconomic	-																		
Heat stroke	High heat can lead to heat stroke if careless	People	Physical	-	None	None	Negligible	Minor	Major	None	Negligible	None	None	None	Moderate	None	Negligible	None	None	None	Minor	Major	1.00
			Environmental	Limited access to green areas/ areas of shade Inadequate access to water and sun screen																		
			Socioeconomic	Population age Population constitution Homeless																		
Agricultural pressure	Issues with provision of water for animals, insufficient water for crops, and reduced grass	Farm animals	Physical	Status of water supply system Number of farm animals present	None	None	Minor	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Water source location																		
			Socioeconomic	Type of farm animals present																		
		Crops	Physical	Irrigation infrastructure	None	None	Minor	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	-																		
			Socioeconomic	-																		
Pressure on recreational areas	High temperatures promotes the use of recreational facilities and puts pressure on existing infrastructure and emergency rescue services	Green areas	Physical	Access to recreational areas Capacity	None	None	Negligible	Minor	Moderate	Minor	Negligible	None	None	None	None	None	Moderate	None	None	Minor	Moderate	Moderate	1.11
			Environmental	Proximity to urban environment Water and waste services																		
			Socioeconomic	Resourcing of staff																		
Heat stress on buildings/ infrastructure	High temperatures resulting in structures being warped/ road surfaces being damaged	Roads and Bridges	Physical	Surface dressed roads susceptible to boiling of bitumen Built Heritage	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	Moderate	None	None	0.22
			Environmental	Available shade cover Proximity to urban environment																		
			Socioeconomic	-																		
		LA Buildings	Physical	Material properties Built Heritage	None	None	None	None	None	None	Negligible	None	Minor	Minor	None	None	None	None	None	None	None	None	0.28
			Environmental	Available shade cover Proximity to urban environment																		
			Socioeconomic	-																		
		Housing	Physical	Material properties Built Heritage	None	None	None	None	None	None	Negligible	None	Minor	Minor	None	None	None	None	None	None	None	None	0.28
			Environmental	Available shade cover Proximity to urban environment																		
			Socioeconomic	-																		
		Pavements	Physical	Historical mixes of concrete prone to heaving	None	None	None	Minor	None	None	Negligible	None	None	None	None	None	Minor	None	None	Minor	None	None	0.39
			Environmental	Located within areas of high solar radiation																		
			Socioeconomic	-																		
Damage to monuments	Drying out of soil can destabilise monuments	Built heritage	Physical	Use of material Built heritage	None	None	None	None	None	None	Negligible	None	Minor	None	None	None	None	None	None	None	Negligible	None	0.22
			Environmental	Located within areas of high solar radiation																		
			Socioeconomic	-																		

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																	
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	Impact Score
Reduced water quality and supply	Water supplies drawing from water with high levels of dissolved material due to evaporation of water sources and water supply plants	Water bodies	Physical	Capacity Concentration of dissolved material	None	None	None	None	None	Moderate	Negligible	None	None	None	Minor	None	Moderate	None	None	None	Moderate	Major	0.89
			Environmental	Presence of shade Located within areas of high solar radiation																		
			Socioeconomic	-																		
		Water supply plants	Physical	Backup water supply	None	None	Moderate	None	Major	None	Negligible	None	None	None	None	None	Moderate	None	None	None	Moderate	Major	1.00
			Environmental	Presence of shade Located within areas of high solar radiation																		
			Socioeconomic	-																		
Damaged water treatment plants	Flows to treatment plants experiencing large amounts of organic loading due to evaporation, disrupting the treatment plant	Wastewater treatment plants	Physical	Capacity Concentration of dissolved material Combined foul and surface system	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	Major	0.28
			Environmental	Proximity to urban environment Water and waste services																		
			Socioeconomic	-																		
Damage to environment	High temperatures can cause vegetation to dry up and die	SAC/SPA/natural habitats	Physical	Vegetation sensitivity to heat	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental	Influenced by time of year Proximity to water bodies																		
			Socioeconomic	-																		

Hazard Event:	**Drought**
Frequency of Occurrence:	Common
Description of the Hazard Event: (including relevant meteorological / climatological conditions and locations affected)	Restrictions on water use. Low rainfall during periods of high temperatures or freezing of water sources/ distribution. There is evidence of a decreasing trend in summer rainfall.



Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																	Impact Score
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Hot and uncomfortable working conditions	High temperatures in homes and office causing discomfort	Outdoor workers	Physical	-	None	None	Moderate	None	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	Minor	0.50
			Environmental	Limited access to green areas/ areas of shade Inadequate access to water/ sun screen/ cooling apparatus																		
			Socioeconomic	Population age Population constitution																		
		Indoor workers	Physical	-	None	None	Moderate	None	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	Minor	0.50
			Environmental	Limited access to green areas/ areas of shade Inadequate access to water/ cooling apparatus																		
			Socioeconomic	Population age Population constitution																		
Pressure on recreational areas	High temperatures promotes the use of recreational facilities and puts pressure on existing infrastructure	Green areas	Physical	Access to recreational areas Capacity	None	None	Negligible	Minor	Minor	Minor	Negligible	None	None	None	None	None	Major	None	None	Minor	Major	Moderate	1.17
			Environmental	Proximity to urban environment Water and waste services																		
			Socioeconomic	-																		
Agricultural pressure	Issues with provision of water for animals, insufficient water for crops, and reduced grass	Farm animals	Physical	Status of water supply system Number of farm animals present	None	None	Minor	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Water source location																		
			Socioeconomic	Type of farm animals present																		
		Crops	Physical	Irrigation infrastructure	None	None	Minor	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	-																		
			Socioeconomic	-																		
Risk of fires	Wildfires or domestic fires are easily started in heatwaves due to the dryness of the environment	People	Physical	Campfires going out of control BBQ's in urban areas gives of stray flame	None	None	None	None	Moderate	None	Negligible	None	None	None	None	None	Negligible	None	None	None	None	None	0.28
			Environmental	Proximity to fire Exposure to fire																		
			Socioeconomic	Population age Population constitution																		
		Environment	Physical	-	None	None	None	None	Moderate	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.39
			Environmental	Proximity to fire Upland areas and gorse areas typically affected Areas of conservation Biodiversity present																		
			Socioeconomic	-																		
		LA Buildings	Physical	Structural integrity Fire proofing of buildings Built Heritage	Negligible	None	Minor	None	Moderate	None	Negligible	None	Minor	None	None	None	None	Minor	None	None	None	None	0.61
			Environmental	Proximity to fire																		
			Socioeconomic	-																		
		Housing	Physical	Structural integrity Fire proofing of buildings Built Heritage	None	None	None	Minor	Moderate	None	Negligible	None	None	Minor	None	None	None	None	None	None	None	None	0.44
			Environmental	Proximity to fire																		
			Socioeconomic	-																		
Heat stress on buildings/ infrastructure	High temperatures resulting in structures being warped/ road surfaces being damaged	Transport infrastructure	Physical	Material properties Built Heritage	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	Moderate	None	None	0.22
			Environmental	Available shade cover Proximity to urban environment																		
			Socioeconomic	-																		
		Buildings	Physical	Material properties Built Heritage	None	None	None	None	None	None	Negligible	None	Minor	Minor	None	None	None	None	None	None	None	None	0.28
			Environmental	Available shade cover Proximity to urban environment																		
			Socioeconomic	-																		
Reduced water quality and supply	Water supplies drawing from water with high levels of dissolved material due to evaporation of water sources and water supply plants	Water bodies	Physical	Capacity Concentration of dissolved material Availability of groundwater	None	None	None	None	None	Moderate	Negligible	None	None	None	Minor	None	Moderate	None	None	None	Moderate	Major	0.89
			Environmental	Presence of shade Located within areas of high solar radiation																		
			Socioeconomic	-																		
		Water supply plants	Physical	Backup water supply Odour issues First flush due to rainfall after drought	None	None	Moderate	None	Major	None	Negligible	None	None	None	None	None	Moderate	None	None	None	Moderate	Major	1.00
			Environmental	Presence of shade Located within areas of high solar radiation																		
			Socioeconomic	Responsibility (Irish Water)																		
Damaged water treatment plants	Flows to treatment plants experiencing large amounts of organic loading due to evaporation, disrupting the treatment plant	Wastewater treatment plants	Physical	Capacity Concentration of dissolved material Combined foul and surface system First flush due to rainfall after drought	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	Major	0.28
			Environmental	Proximity to urban environment Water and waste services																		
			Socioeconomic	-																		
Damage to environment	High temperatures can cause vegetation to dry up and die	SAC/SPA/natural habitats	Physical	Vegetation sensitivity to heat Lowered water levels	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental	Influenced by time of year Proximity to water bodies																		
			Socioeconomic	-																		

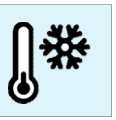
Hazard Event:	**Above Average Surface Temperature**
Frequency of Occurrence:	Common
Description of the Hazard Event: (Including relevant meteorological / climatological conditions and locations affected)	Prolonged periods of higher than average temperatures. Observations indicate an increase in the surface temperature for Ireland of 0.9°C over the last 120 years. Urban areas particularly affected.

Hazard Impact	Impact Description:	Exposure	Vulnerability: Type	Vulnerability: Description	Service Areas: Level of Disruption: Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	Impact Score
Change in biodiversity	Changes in surface temperatures leads to a promotion in growth of invasive species to the detriment to native species	Invasive species	Physical	Growing conditions required of the invasive flora	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental	Influenced by time of year																			
			Socioeconomic	Invasive Alien Plant Species protocols in place to reduce the spread of invasive species																			
		Native species	Physical	Growing conditions required of the native flora	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental	Influenced by time of year																			
			Socioeconomic	-																			
Change in phenology	Changes in surface temperatures leads to a disruption to the phenology cycle, affecting pollinators and seasonal interactions	Pollinators	Physical	Sensitivity of pollinators to changes in temperatures	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental																				
			Socioeconomic	-																			
Hot and uncomfortable working conditions	High temperatures in homes and office causing discomfort	Dwellings	Physical	Inadequate cooling mechanisms	None	None	None	Minor	None	None	Negligible	None	None	Minor	None	None	None	None	None	None	None	Minor	0.39
			Environmental	Proximity to high density urban areas																			
			Socioeconomic	-																			
		Outdoor workers	Physical	-	None	None	Moderate	None	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	Minor	0.50
			Environmental	Limited access to green areas/ areas of shade Inadequate access to water/ sun screen/ cooling apparatus																			
			Socioeconomic	Population age Population constitution																			
		Indoor workers	Physical	-	None	None	Moderate	None	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	Minor	0.50
			Environmental	Limited access to green areas/ areas of shade Inadequate access to water/ cooling apparatus																			
			Socioeconomic	Population age Population constitution																			
Risk of fires	Wildfires or domestic fires are easily started in heatwaves due to the dryness of the environment	People	Physical	Campfires going out of control BBQ's in urban areas gives of stray flame	None	None	None	None	Moderate	None	Negligible	None	None	None	None	None	Negligible	None	None	None	None	None	0.28
			Environmental	Proximity to fire Exposure to fire																			
			Socioeconomic	Population age Population constitution																			
		Environment	Physical	-	None	None	None	None	Moderate	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.39
			Environmental	Proximity to fire Upland areas and gorse areas typically affected Areas of conservation Biodiversity present																			
			Socioeconomic	-																			
		LA Buildings	Physical	Structural integrity Fire proofing of buildings Built Heritage	Negligible	None	Minor	None	Moderate	None	Negligible	None	Minor	None	None	None	None	Minor	None	None	None	None	0.61
			Environmental	Proximity to fire																			
			Socioeconomic	-																			
		Housing	Physical	Structural integrity Fire proofing of buildings Built Heritage	None	None	None	Minor	Moderate	None	Negligible	None	None	Minor	None	None	None	None	None	None	None	None	0.44
			Environmental	Proximity to fire																			
			Socioeconomic	-																			
Agricultural pressure	Issues with provision of water for animals, insufficient water for crops, and reduced grass	Farm animals	Physical	Status of water supply system Number of farm animals present	None	None	Minor	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Water source location																			
			Socioeconomic	Type of farm animals present																			
		Crops	Physical	Irrigation infrastructure	None	None	Minor	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	-																			
			Socioeconomic	-																			
Pressure on recreational areas	High temperatures promotes the use of recreational facilities and puts pressure on existing infrastructure	Green areas	Physical	Access to recreational areas Capacity	None	None	Negligible	Minor	Minor	Minor	Negligible	None	None	None	None	None	Moderate	None	None	Minor	Moderate	Moderate	1.06
			Environmental	Proximity to urban environment Water and waste services																			
			Socioeconomic	-																			
Heat stress on buildings/ infrastructure	High temperatures resulting in structures being warped/ road surfaces being damaged	Transport infrastructure	Physical	Material properties Built Heritage	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	Moderate	None	None	0.22
			Environmental	Available shade cover Proximity to urban environment																			
			Socioeconomic	-																			
		Buildings	Physical	Material properties Built Heritage	None	None	None	None	None	None	Negligible	None	Minor	Minor	None	None	None	None	None	None	None	None	0.28
			Environmental	Available shade cover Proximity to urban environment																			
			Socioeconomic	-																			
Reduced water quality and supply	Water supplies drawing from water with high levels of dissolved material due to evaporation of water sources and water supply plants	Water bodies	Physical	Capacity Concentration of dissolved material	None	None	None	None	None	Moderate	Negligible	None	None	None	Minor	None	Moderate	None	None	None	Moderate	Moderate	0.83
			Environmental	Presence of shade Located within areas of high solar radiation																			
			Socioeconomic	-																			
		Water supply plants	Physical	Backup water supply	None	None	Moderate	None	None	None	Negligible	None	None	None	None	None	Moderate	None	None	None	Moderate	Moderate	0.72
			Environmental	Presence of shade Located within areas of high solar radiation																			
			Socioeconomic	Resoonsibility (Irish Water)																			
Damaged water treatment plants	Flows to treatment plants experiencing large amounts of organic loading due to evaporation, disrupting the treatment plant	Wastewater treatment plants	Physical	Capacity Concentration of dissolved material Combined foul and surface system	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	Moderate	0.22
			Environmental	Proximity to urban environment Water and waste services																			
			Socioeconomic	-																			
Damage to environment	High temperatures can cause vegetation to dry up and die	SAC/SPA/natural habitats	Physical	Vegetation sensitivity to heat	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental	Influenced by time of year Proximity to water bodies																			
			Socioeconomic	-																			

Hazard Event:	**Above Average Precipitation**
Frequency of Occurrence:	Common
Description of the Hazard Event: (Including relevant meteorological / climatological conditions and locations affected)	Prolonged periods of rainfall. Change in pattern of typical rainfall periods.

Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																	Impact Score
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Reduced water quality	Vegetation debris or leachates from surface run off entering water systems	Water bodies	Physical	Sewage overflow inputs into water bodies Gradient of ground Water turbidity Capacity	None	None	None	Minor	None	Minor	Negligible	None	None	None	None	None	None	None	None	None	None	Moderate	0.44
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																			
			Socioeconomic	-																			
		Water supply distribution	Physical	-	None	None	None	Minor	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	Moderate	0.33
			Environmental	Impermeability of surface Ground elevation and gradient relative to surrounding area Proximity to urban environment																			
			Socioeconomic	Extended workload and overtime leading to burnout and availability of monitoring staff Resoonsibility (Irish Water)																			
Land erosion	Rainfall causing ground saturation, weakening ground strength	Land/cliffsides	Physical	Soil properties	None	None	None	None	Moderate	Moderate	Negligible	None	None	None	None	None	None	None	Negligible	None	None	None	0.44
			Environmental	Ground elevation and gradient relative to surrounding area Proximity to urban environment																			
			Socioeconomic	-																			
More time spent indoors	Increased rainfall dissuading people to be outdoors	Mental health	Physical	-	None	None	Minor	Moderate	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	None	0.50
			Environmental	Proximity to facilities																			
			Socioeconomic	Population age Population constitution Home dynamics - living alone or with family																			
		Commerce	Physical	-	None	None	Moderate	None	None	None	Negligible	None	None	None	None	Minor	Moderate	None	None	None	Moderate	None	0.67
			Environmental	Ground elevation and gradient relative to surrounding area Proximity to urban environment																			
			Socioeconomic	-																			
Erosion of structures	Chemical reaction dissolving structures/ scour	LA buildings	Physical	Use of material Built Heritage	None	None	None	None	None	None	Negligible	None	Minor	None	None	None	None	None	None	None	None	None	0.17
			Environmental	-																			
			Socioeconomic	-																			
		Road network	Physical	Use of material Built Heritage	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	Negligible	None	None	0.11
			Environmental	-																			
			Socioeconomic	-																			
		Housing	Physical	Use of material Built Heritage	None	None	None	None	None	None	Negligible	None	None	Negligible	None	None	None	None	None	None	None	None	0.11
			Environmental	-																			
			Socioeconomic	-																			

Hazard Event:	**Cold Spell**
Frequency of Occurrence:	Common
Description of the Hazard Event: (Including relevant meteorological / climatological conditions and locations affected)	Record low temperatures with temperatures between 0 and -10 degrees C throughout Winter.



Hazard Impact	Impact Description:	Exposure	Vulnerability		Service Areas: Level of Disruption																		Impact Score
			Type	Description	Archives	Arts and Culture	Business and Economy	Community	Emergency Services	Environment	Finance	Governance and Administration	Built Heritage and Conservation	Housing	Human Resources	Information Technology	Leisure and Recreation	Libraries and Museums	Planning and Building	Roads and Transport	Tourism	Water Services	
Cold and uncomfortable working conditions	Low temperatures in homes and office causing discomfort	Outdoor workers	Physical	-	None	None	Moderate	None	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	Minor	0.50
			Environmental	Limited access to heating apparatus/ shelter																			
			Socioeconomic	Population age Population constitution																			
		Indoor workers	Physical	-	None	None	Moderate	None	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	Minor	0.50
			Environmental	Limited access to heating apparatus																			
			Socioeconomic	Population age Population constitution																			
Frostbite	Low temperatures can lead to frostbite if careless	People	Physical	-	None	None	Negligible	Minor	Major	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	Major	0.83
			Environmental	Proximity to urban environment																			
			Socioeconomic	Population age Population constitution Homeless																			
Cold stress on buildings/ infrastructure	Low temperatures resulting in structures being warped/ road surfaces being damaged	Transport infrastructure	Physical	Material properties Built Heritage Changes in rates of deterioration - faster rate of deterioration in areas subject to sustained low temperatures	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	Moderate	None	None	0.22
			Environmental	Proximity to urban environment																			
			Socioeconomic	-																			
		LA Buildings	Physical	Material properties Built Heritage	None	None	Minor	None	None	None	Negligible	None	Minor	Minor	None	None	None	None	None	None	None	None	0.39
			Environmental	Proximity to urban environment																			
			Socioeconomic	-																			
		Housing	Physical	Material properties Built Heritage	None	None	None	None	Minor	None	Negligible	None	Minor	Minor	None	None	None	None	None	None	None	None	0.39
			Environmental	Proximity to urban environment																			
			Socioeconomic	Requirement for additional heat and additional insulation of housing stock																			
Reduced water quality and supply	Frozen water restrict extraction and distribution of water	Water bodies	Physical	Depth of water	None	None	None	None	None	Major	Negligible	None	None	None	Minor	None	Moderate	None	None	None	Moderate	Major	0.94
			Environmental	Elevation in relation to sea level																			
			Socioeconomic	-																			
		Water supply infrastructure	Physical	Backup water supply Air volume in pipes	None	None	Moderate	None	Major	None	Negligible	None	None	None	None	None	Moderate	None	None	None	Moderate	Major	1.00
			Environmental	Elevation in relation to sea level																			
			Socioeconomic	-																			
Damaged water supply and treatment plants	Frozen water damaging treatment systems	Water and wastewater treatment plants	Physical	Air volume in pipes Combined foul and surface system	None	None	None	None	None	None	Negligible	None	None	None	None	None	None	None	None	None	None	Major	0.28
			Environmental	Elevation in relation to sea level																			
			Socioeconomic	-																			
Change in phenology	Changes in surface temperatures leads to a disruption to the phenology cycle	River habitats	Physical	Low temperatures bring about changes in species distribution and phenology of river systems	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental																				
			Socioeconomic	-																			
More time spent indoors	Cold temperatures dissuades people from going outdoors	Mental health	Physical	-	None	None	Minor	Moderate	None	None	Negligible	None	None	None	Moderate	None	None	None	None	None	None	None	0.50
			Environmental	Proximity to facilities																			
			Socioeconomic	Population age Population constitution Home dynamics - living alone or with family																			
Reduced air quality	Low temperatures lead to less active travel and the need for more heat in buildings, increasing burning of fossil fuels	Air	Physical	Level of insulation of buildings	None	None	None	None	None	Minor	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.17
			Environmental	Proximity to urban environment																			
			Socioeconomic	-																			
		People	Physical	-	None	None	None	Negligible	Negligible	None	Negligible	None	None	None	Negligible	None	None	None	None	None	None	None	0.22
			Environmental	-																			
			Socioeconomic	Population age Population constitution Homeless																			
Damage to environment	Low temperatures can cause vegetation to freeze and die	SAC/SPA/natural habitats	Physical	Vegetation sensitivity to cold	None	None	None	None	None	Moderate	Negligible	None	None	None	None	None	None	None	None	None	None	None	0.22
			Environmental	Prolonged road salting affecting salinity of surrounding ground Influenced by time of year																			
			Socioeconomic	-																			
		Agricultural land	Physical	-	None	None	Negligible	Minor	Minor	Minor	Negligible	None	None	None	None	None	Major	None	None	Minor	Major	Moderate	1.17
			Environmental	Prolonged road salting affecting salinity of surrounding ground Influenced by time of year																			
			Socioeconomic	-																			

Appendix E Current Impact Summary Matrix

CURRENT IMPACTS		Hazard Type	Current Frequency	Current Frequency (Score)	Asset Damage	Health and Wellbeing	Environment	Social	Financial	Reputation	Cultural Heritage	Current Impact
		River flood	Frequent	4	Major	Major	Moderate	Moderate	Moderate	Moderate	Moderate	3.29
		Extreme precipitation	Very Frequent	5	Moderate	Minor	Minor	Minor	Minor	Minor	Moderate	2.29
		Drought	Common	3	Minor	Moderate	Moderate	Moderate	Minor	Minor	Negligible	2.29
		Severe windstorm	Very frequent	5	Minor	Moderate	Moderate	Minor	Negligible	Negligible	Moderate	2.14
		Heatwave	Common	3	Minor	Moderate	Moderate	Minor	Negligible	Negligible	Moderate	2.14
		Pluvial flood	Common	3	Moderate	Minor	Minor	Minor	Negligible	Minor	Minor	2.00
		Above average precipitation	Common	3	Moderate	Minor	Minor	Minor	Negligible	Negligible	Moderate	2.00
		Above average surface temperature	Common	3	Negligible	Negligible	Major	Negligible	Negligible	Negligible	Moderate	1.71
		Cold spell	Common	3	Minor	Minor	Negligible	Minor	Minor	Negligible	Minor	1.71
		Heavy snowfall	Common	3	Minor	Minor	Minor	Negligible	Minor	Negligible	Minor	1.71

Appendix F Assessment of Future Climate Hazards and Impacts

Assessment of Future Climate Hazards

Hazard No.	Hazard Type		Current Frequency	Projected Frequency	Evidence Base
1		River flood	Frequent	Very Frequent	An analysis of river flows over a period of more than 50 years of data (1972-2017) indicates an increase in river flows across most of the country (Status of Ireland's Climate, EPA) and an increase in the projected frequency of very wet days (>30mm of precipitation) which will likely increase the frequency of flood events (www.climateireland.ie).
2		Pluvial flood	Common	Frequent	When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA) and an increase in the projected frequency of very wet days (>30mm of precipitation). Projections of precipitation indicate that precipitation is expected to become more variable with increases in dry periods in the summer and heavy precipitation in winter (www.climateireland.ie).
3		Above average precipitation	Common	Frequent	When compared with an annual average rainfall of 1186mm in the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall. The last decade from 2006 - 2015 has been the wettest period in the period 1711- 2016 and there is evidence of an increasing trend in winter rainfall and a decreasing trend in summer rainfall (Status of Ireland's Climate, EPA).
4		Extreme precipitation	Very Frequent	Very Frequent	There is an increase in the projected frequency of very wet days (>30mm of precipitation) (Status of Ireland's Climate, EPA) and observed increases in the levels of winter rainfall but a decrease in summer rainfall (www.climateireland.ie).
5		Severe windstorm	Very frequent	Very Frequent	No long-term trend in wind speed can be determined with confidence based on the limited analysis carried out to date. Climate projections (www.climateireland.ie) indicate an decrease in the number of less intense storms but an increase in the storms which are rare events. Due to a limited number of studies, these projections should be considered with a high level of caution (A Multi-model ensemble approach, EPA).
6		Heatwave	Common	Frequent	Climate projections (www.climateireland.ie) indicate an increase in the average surface air temperatures across all seasons which will likely increase the intensity and frequency of heatwaves. There has been an increase in the number of warm days (temperature > 20°C). This is in line with trends evident for the rest of Western Europe (Status of Ireland's Climate, EPA).
7		Drought	Common	Frequent	Climate projections (www.climateireland.ie) indicate an increase in the average surface temperature as well as a decrease in the levels of summer rainfall (Status of Ireland's Climate, EPA) which will likely increase the intensity and frequency of droughts in the summer. An analysis on river flows over a period from 1992-2017 suggests an increase in drought conditions in the summer, particularly in the east of the country (Status of Ireland's Climate, EPA).
8		Above average surface temperature	Common	Frequent	Climate projections (www.climateireland.ie) indicate an increase in the average surface air temperatures across all seasons which will likely increase the intensity and frequency of heatwaves. There has been an increase in the number of warm days (temperature > 20°C). This is in line with trends evident for the rest of Western Europe (Status of Ireland's Climate, EPA).
9		Cold spell	Common	Occasional	There has been a decrease in the number of frost days (temperatures below 0°C) and a shortening of the frost season duration (www.climateireland.ie).
10		Heavy snowfall	Common	Occasional	Snowfall is projected to decrease substantially by the middle of the century (Nolan and Flanagan), but not to the extent where the frequency is considered rare.

Assessment of Future Climate Impacts - Asset Damage					
Hazard No.	Hazard Type		Current Asset Damage	Projected Change	Rationale
1		River flood	Major	Major	Densification of urban areas to deliver compact growth will potentially increase the amount of properties at risk of flooding. However, the Carlow CDP outlines an objective to ensure vulnerable developments are directed away from areas at risk of flooding. Works will also be continued with OPW to develop flood relief schemes and maintain existing defences. There is a likely increase in river flows across most of the country leading to an increase in severity of flooding (Climate Ireland).
2		Pluvial flood	Moderate	Moderate	Similarly to river flooding, densification of urban areas will potentially increase the amount of properties at risk. Adaptation and spatial planning goals include the conversion of land at risk of flooding to less vulnerable uses e.g. parks, gardens and open spaces for natural habitats (Carlow CDP). Works will also be continued with OPW to develop flood relief schemes and maintain existing defences. When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
3		Above average precipitation	Moderate	Moderate	Future developments will be required to utilise sustainable urban drainage systems to control the release of water runoff in a managed way (Carlow CDP). The last decade from 2006 - 2015 has been the wettest period in the period 1711- 2016 and there is evidence of an increasing trend in winter rainfall and a decreasing trend in summer rainfall (Status of Ireland's Climate, EPA). This implies there is an increase in severity in winter periods but a reduction in summer periods.
4		Extreme precipitation	Moderate	Moderate	Future developments will be required to utilise sustainable urban drainage systems to control the release of water runoff in a managed way (Carlow CDP). When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
5		Severe windstorm	Minor	Moderate	Current predictions indicate an increase in the intensity of windstorms (Climate Ireland), increasing the impacts involved.
6		Heatwave	Minor	Minor	Average surface air temperatures are expected to increase across all seasons which will likely increase the intensity of heatwaves (Climate Ireland). New building regulations and materials will be required for use in new developments to accommodate this, but there will also be an increase in the impact of heatwaves due to more compacted urban areas (Carlow CDP).
7		Drought	Minor	Moderate	Average surface temperature are expected in increase, as well as a decrease in the levels of summer rainfall (Status of Ireland's Climate, EPA), leading to an increase in the impact of droughts.
8		Above average surface temperature	Negligible	Negligible	Average surface air temperatures across all seasons are expected to increase (Climate Ireland). New building design and materials will be introduced to accommodate hotter summers without compromising resilience to other climate changes, but densification of urban areas will potentially increase the solar radiation of urban areas (Carlow CDP).
9		Cold spell	Minor	Minor	No changes in the assets affected. There has been a decrease in the number of frost days (temperatures below 0°C) and a shortening of the frost season duration, with projections to be in line with current trends (Climate Ireland). However, the impact remains as a minor impact.
10		Heavy snowfall	Minor	Minor	No changes in the assets affected. Snowfall is projected to decrease substantially by the middle of the century (Nolan and Flanagan), but impacts will remain the same.

Assessment of Future Climate Impacts - Health and Wellbeing					
Hazard No.	Hazard Type		Current Health and Wellbeing Impact	Projected Change	Rationale
1		River flood	Major	Major	Densification of urban areas to deliver compact growth will potentially increase the amount of properties at risk of flooding. However, the Carlow CDP outlines an objective to ensure vulnerable developments are directed away from areas at risk of flooding. Works will also be continued with OPW to develop flood relief schemes and maintain existing defences. There is a likely increase in river flows across most of the country leading to an increase in severity of flooding (Climate Ireland).
2		Pluvial flood	Minor	Minor	The Carlow CDP outlines an objective to ensure vulnerable developments are directed away from areas at risk of flooding. Compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
3		Above average precipitation	Minor	Minor	Promoting awareness for mental health issues and improvement of mental health services are envisaged (Carlow LECP Statement). The last decade from 2006 - 2015 has been the wettest period in the period 1711- 2016 and there is evidence of an increasing trend in winter rainfall and a decreasing trend in summer rainfall (Status of Ireland's Climate, EPA). This implies there is an increase in severity in winter periods but a reduction in summer periods.
4		Extreme precipitation	Minor	Minor	Promoting awareness for mental health issues and improvement of mental health services are envisaged (Carlow LECP Statement). When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA). This increase in rainfall intensity is seen during the winter season while summers will see a decrease in the level of precipitation, balancing one another.
5		Severe windstorm	Moderate	Major	Changing demographics with an increase in elderly population and densification of urban areas will potentially increase exposure and vulnerability (Carlow LECP Profile). Current predictions indicate an increase in the intensity of windstorms (Climate Ireland), increasing the impacts involved.
6		Heatwave	Moderate	Moderate	Average surface air temperatures are expected to increase across all seasons which will likely increase the intensity of heatwaves (Climate Ireland). Protecting and expanding green infrastructure will help to reduce the increase in intensity of this event (Carlow CDP).
7		Drought	Moderate	Major	Changing demographics with an increase in elderly population and densification of urban areas will potentially increase exposure and vulnerability (Carlow LECP Profile). Average surface temperature are expected in increase, as well as a decrease in the levels of summer rainfall (Status of Ireland's Climate, EPA).
8		Above average surface temperature	Negligible	Negligible	Average surface air temperatures across all seasons are expected to increase (Climate Ireland). Adaptation goals for County Carlow include the expansion of the county's green infrastructure, reducing any impacts to health and wellbeing by ensuring the presence of facilities to use in high temperatures (Carlow CDP).
9		Cold spell	Minor	Minor	Increase in vulnerable population, e.g., elderly population, may increase the possible impacts (Carlow LECP Profile). However, there has been a decrease in the number of frost days (temperatures below 0°C) and a shortening of the frost season duration, with projections to be in line with current trends (Climate Ireland). However, the impact remains as a minor impact.
10		Heavy snowfall	Minor	Minor	The increasing elderly population increases the possible impacts of heavy snowfalls (Carlow LECP Profile). However, snowfall is projected to decrease substantially by the middle of the century (Nolan and Flanagan), but impacts will remain the same.

Assessment of Future Climate Impacts - Environment					
Hazard No.	Hazard Type		Current Environment Impact	Projected Change	Rationale
1		River flood	Moderate	Moderate	Actions to mitigate impacts include managing development in flood risk areas and requiring SuDS to be used in all relevant developments to avoid surface water run-off and pollutants entering watercourses (Carlow CDP). There is a likely increase in river flows across most of the country leading to an increase in severity of flooding (Climate Ireland).
2		Pluvial flood	Minor	Moderate	Actions to mitigate impacts include managing development in flood risk areas and requiring SuDS to be used in all relevant developments to avoid surface water run-off and pollutants entering watercourses (Carlow CDP). When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
3		Above average precipitation	Minor	Minor	Requirement for the use of SuDS in new developments mitigate the effects of impacts to the environment (Carlow CDP). The last decade from 2006 - 2015 has been the wettest period in the period 1711- 2016 and there is evidence of an increasing trend in winter rainfall and a decreasing trend in summer rainfall (Status of Ireland's Climate, EPA). This implies there is an increase in severity in winter periods but a reduction in summer periods.
4		Extreme precipitation	Minor	Moderate	Requirement for the use of SuDS in new developments mitigate the effects of impacts to the environment (Carlow CDP). When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
5		Severe windstorm	Moderate	Major	Current predictions indicate an increase in the intensity of windstorms (Climate Ireland), increasing the impacts involved. Protection measures are being implemented on ecosystems such as dune habitat systems (Carlow CDP).
6		Heatwave	Moderate	Major	Changes in phenology are projected to be experienced as average surface air temperatures are expected to increase across all seasons which will likely increase the intensity of heatwaves (Climate Ireland). This will affect the blooming seasons of flora, affecting the pollinating cycle.
7		Drought	Moderate	Major	Given the overall effect of climate change on environmental assets, many will be stressed from a range of factors, reducing the capacity of these assets to sustain acute and chronic events leading to an expected increase in impact. Average surface temperature are expected in increase, as well as a decrease in the levels of summer rainfall (Status of Ireland's Climate, EPA).
8		Above average surface temperature	Major	Catastrophic	Changes in phenology are projected to be experienced as average surface air temperatures across all seasons are expected to increase (Climate Ireland). This will affect the blooming seasons of flora, affecting the pollinating cycle.
9		Cold spell	Negligible	Negligible	There has been a decrease in the number of frost days (temperatures below 0°C) and a shortening of the frost season duration, with projections to be in line with current trends (Climate Ireland). However, the impact remains negligible.
10		Heavy snowfall	Minor	Minor	Snowfall is projected to decrease substantially by the middle of the century (Nolan and Flanagan), but impacts will remain the same.

Assessment of Future Climate Impacts - Social					
Hazard No.	Hazard Type		Current Social Impact	Projected Change	Rationale
1		River flood	Moderate	Moderate	Actions to avoid locating vulnerable developments in areas at risk of flooding are envisaged (Carlow CDP). There is a likely increase in river flows across most of the country leading to an increase in severity of flooding (Climate Ireland).
2		Pluvial flood	Minor	Minor	Actions to avoid locating vulnerable developments in areas at risk of flooding are envisaged (Carlow CDP). When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
3		Above average precipitation	Minor	Minor	Promoting awareness for mental health issues and improvement of mental health services are envisaged (Carlow LECP Statement). The last decade from 2006 - 2015 has been the wettest period in the period 1711- 2016 and there is evidence of an increasing trend in winter rainfall and a decreasing trend in summer rainfall (Status of Ireland's Climate, EPA). This implies there is an increase in severity in winter periods but a reduction in summer periods.
4		Extreme precipitation	Minor	Minor	Promoting awareness for mental health issues and improvement of mental health services are envisaged (Carlow LECP Statement). When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
5		Severe windstorm	Minor	Minor	Changing demographics with an increasing elderly population and densification of urban areas will potentially increase exposure and vulnerability (Carlow LECP Profile). Current predictions indicate an increase in the intensity of windstorms (Climate Ireland), increasing the impacts involved for the vulnerable population, e.g., the homeless.
6		Heatwave	Minor	Minor	Changing demographics with an increasing elderly population and densification of urban areas will potentially increase exposure and vulnerability (Carlow LECP Profile). Average surface air temperatures are expected to increase across all seasons which will likely increase the intensity of heatwaves (Climate Ireland).
7		Drought	Moderate	Moderate	Changing demographics with an increasing elderly population and densification of urban areas will potentially increase exposure and vulnerability however, not enough to make this a moderate future impact. Average surface temperature are expected in increase, as well as a decrease in the levels of summer rainfall (Status of Ireland's Climate, EPA).
8		Above average surface temperature	Negligible	Minor	Average surface air temperatures across all seasons are expected to increase (Climate Ireland). Uncomfortable conditions for more vulnerable population may be at risk of an increased impact.
9		Cold spell	Minor	Minor	There has been a decrease in the number of frost days (temperatures below 0°C) and a shortening of the frost season duration, with projections to be in line with current trends (Climate Ireland). However, the impact remains as a minor impact.
10		Heavy snowfall	Negligible	Negligible	Snowfall is projected to decrease substantially by the middle of the century (Nolan and Flanagan), but impacts will remain the same.

Assessment of Future Climate Impacts - Financial					
Hazard No.	Hazard Type		Current Financial Impact	Projected Change	Rationale
1		River flood	Moderate	Major	The increase in impact across a range of areas of the local authority could lead to an increasing financial burden on the local authority (Carlow CDP). There is a likely increase in river flows across most of the country leading to an increase in severity of flooding (Climate Ireland).
2		Pluvial flood	Negligible	Minor	The increase in impact across a range of areas of the local authority could lead to an increasing financial burden on the local authority (Carlow CDP). When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
3		Above average precipitation	Negligible	Negligible	The last decade from 2006 - 2015 has been the wettest period in the period 1711- 2016 and there is evidence of an increasing trend in winter rainfall and a decreasing trend in summer rainfall (Status of Ireland's Climate, EPA). This implies there is an increase in severity in winter periods but a reduction in summer periods. It is unlikely the financial burden will be increased.
4		Extreme precipitation	Minor	Minor	When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
5		Severe windstorm	Negligible	Minor	The increase in impact across a range of areas of the local authority could lead to an increasing financial burden on the local authority (Carlow CDP). Current predictions indicate an increase in the intensity of windstorms (Climate Ireland), increasing the impacts involved.
6		Heatwave	Negligible	Negligible	Average surface air temperatures are expected to increase across all seasons which will likely increase the intensity of heatwaves (Climate Ireland). Use of new materials to accommodate higher temperatures are unlikely to increase the financial burden to the point where the impacts are minor (Carlow CDP).
7		Drought	Minor	Moderate	Average surface temperature are expected in increase, as well as a decrease in the levels of summer rainfall (Status of Ireland's Climate, EPA). Drier summers result in an increasing financial burden for the provision of water.
8		Above average surface temperature	Negligible	Minor	Average surface air temperatures across all seasons are expected to increase (Climate Ireland). A possible increase in the measures to protect and enhance green infrastructure to accommodate this increase in baseline temperatures may lead to an increased burden on finances. There is a large draw on resources currently which may increase if more resilient planting is introduced.
9		Cold spell	Minor	Minor	There has been a decrease in the number of frost days (temperatures below 0°C) and a shortening of the frost season duration, with projections to be in line with current trends (Climate Ireland). However, the impact remains as a minor impact.
10		Heavy snowfall	Minor	Minor	Snowfall is projected to decrease substantially by the middle of the century (Nolan and Flanagan), but impacts will remain the same.

Assessment of Future Climate Impacts - Reputational

Hazard No.	Hazard Type		Current Reputational Impact	Projected Change	Rationale
1		River flood	Moderate	Moderate	There is a likely increase in river flows across most of the country leading to an increase in severity of flooding (Climate Ireland). The local authority has a role in addressing these issues, and could therefore suffer reputational damage from local, national, and international perspectives. The CARO progress report 2022 indicates progress has been made with regards to climate change adaptation implementation with this event.
2		Pluvial flood	Minor	Minor	When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA). The local authority has a role in addressing these issues, and could therefore suffer reputational damage from local, national, and international perspectives. The CARO progress report 2022 indicates progress has been made with regards to climate change adaptation implementation with this event.
3		Above average precipitation	Negligible	Negligible	The last decade from 2006 - 2015 has been the wettest period in the period 1711- 2016 and there is evidence of an increasing trend in winter rainfall and a decreasing trend in summer rainfall (Status of Ireland's Climate, EPA). This implies there is an increase in severity in winter periods but a reduction in summer periods. The local authority has a role in addressing these issues, and could therefore suffer reputational damage from local, national, and international perspectives. The CARO progress report 2022 indicates progress has been made with regards to climate change adaptation implementation.
4		Extreme precipitation	Minor	Minor	When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).The local authority has a role in addressing these issues, and could therefore suffer reputational damage from local, national, and international perspectives. The CARO progress report 2022 indicates progress has been made with regards to climate change adaptation implementation.
5		Severe windstorm	Negligible	Negligible	Current predictions indicate an increase in the intensity of windstorms (Climate Ireland), increasing the impacts involved. The local authority has a role in addressing these issues, and could therefore suffer reputational damage from local, national, and international perspectives. The CARO progress report 2022 indicates progress has been made with regards to climate change adaptation implementation.
6		Heatwave	Negligible	Negligible	Average surface air temperatures are expected to increase across all seasons which will likely increase the intensity of heatwaves (Climate Ireland). The local authority has a role in addressing these issues, and could therefore suffer reputational damage from local, national, and international perspectives. The CARO progress report 2022 indicates progress has been made with regards to climate change adaptation implementation.
7		Drought	Minor	Moderate	Average surface temperature are expected in increase, as well as a decrease in the levels of summer rainfall (Status of Ireland's Climate, EPA).The local authority has a role in addressing these issues, and could therefore suffer reputational damage from local, national, and international perspectives.
8		Above average surface temperature	Negligible	Negligible	Average surface air temperatures across all seasons are expected to increase (Climate Ireland). The local authority has a role in addressing these issues, and could therefore suffer reputational damage from local, national, and international perspectives. The CARO progress report 2022 indicates progress has been made with regards to climate change adaptation implementation.
9		Cold spell	Negligible	Negligible	There has been a decrease in the number of frost days (temperatures below 0°C) and a shortening of the frost season duration, with projections to be in line with current trends (Climate Ireland). However, the impact remains negligible.
10		Heavy snowfall	Negligible	Negligible	Snowfall is projected to decrease substantially by the middle of the century (Nolan and Flanagan), but impacts will remain the same.

Assessment of Future Climate Impacts - Cultural Heritage					
Hazard No.	Hazard Type		Current Cultural Heritage Impact	Projected Change	Rationale
1		River flood	Moderate	Major	There could be an increase in the number of cultural heritage assets exposed to river flooding due to an increase in severity of flooding events. There is a likely increase in river flows across most of the country leading to an increase in severity of flooding (Climate Ireland). The objective is to continue to work alongside OPW to carry out flood relief schemes and maintain existing defences (Carlow CDP).
2		Pluvial flood	Minor	Moderate	There could be an increase in the number of cultural heritage assets exposed to pluvial flooding due to an increase in severity of flooding events, and an increase in the overall impact is expected. When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA). The objective is to continue to work alongside OPW to carry out flood relief schemes and maintain existing defences (Carlow CDP).
3		Above average precipitation	Moderate	Moderate	Above average precipitation does not impact the majority of cultural heritage assets so a significant increase in overall impact is not envisaged. The last decade from 2006 - 2015 has been the wettest period in the period 1711- 2016 and there is evidence of an increasing trend in winter rainfall and a decreasing trend in summer rainfall (Status of Ireland's Climate, EPA). This implies there is an increase in severity in winter periods but a reduction in summer periods.
4		Extreme precipitation	Moderate	Moderate	Extreme precipitation does not impact the majority of cultural heritage assets so a significant increase in overall impact is not envisaged. When compared with an annual average rainfall of 1186mm for the period 1961-1990, the thirty year period 1990-2019 shows a 70mm or almost 7% increase in rainfall (Status of Ireland's Climate, EPA).
5		Severe windstorm	Moderate	Moderate	The projected changes in severe windstorms indicate a reduction in lesser storms but an increase in major storms. The overall impact is expected to remain relatively unchanged as storms may be less frequent but the damage caused may increase. Current predictions indicate an increase in the intensity of windstorms (Climate Ireland), increasing the impacts involved.
6		Heatwave	Moderate	Moderate	Areas of cultural heritage may have an increase in visitors during these events, increasing pressure on these areas, but not enough to increase the impact. Average surface air temperatures are expected to increase across all seasons which will likely increase the intensity of heatwaves (Climate Ireland).
7		Drought	Negligible	Negligible	Droughts do not impact the majority of cultural heritage assets so a significant increase in overall impact is not envisaged (Carlow CDP). Average surface temperature are expected in increase, as well as a decrease in the levels of summer rainfall (Status of Ireland's Climate, EPA).
8		Above average surface temperature	Moderate	Moderate	Areas of cultural heritage may have an increase in visitors as a result of increased average surface temperatures, increasing pressure on these areas, but not enough to increase a major impact. Average surface air temperatures across all seasons are expected to increase (Climate Ireland).
9		Cold spell	Minor	Minor	Cold spells do not impact the majority of cultural heritage assets so a significant increase in overall impact is not envisaged. There has been a decrease in the number of frost days (temperatures below 0°C) and a shortening of the frost season duration, with projections to be in line with current trends (Climate Ireland). However, the impact remains as a minor impact.
10		Heavy snowfall	Minor	Minor	Heavy snowfalls do not impact the majority of cultural heritage assets so a significant increase in overall impact is not envisaged. Snowfall is projected to decrease substantially by the middle of the century (Nolan and Flanagan), but impacts will remain the same.

Appendix G Future Impact Summary Matrix

FUTURE IMPACTS

	Hazard Type	Projected Frequency	Projected Frequency (Score)	Asset Damage	Health and Wellbeing	Environment	Social	Financial	Reputation	Cultural Heritage	Projected Impact
	River flood	Very Frequent	5	Major	Major	Moderate	Moderate	Major	Moderate	Major	3.57
	Drought	Frequent	4	Moderate	Major	Major	Moderate	Moderate	Moderate	Negligible	3.00
	Severe windstorm	Very Frequent	5	Moderate	Major	Major	Minor	Minor	Negligible	Moderate	2.71
	Pluvial flood	Frequent	4	Moderate	Minor	Moderate	Minor	Minor	Minor	Moderate	2.43
	Extreme precipitation	Very Frequent	5	Moderate	Minor	Moderate	Minor	Minor	Minor	Moderate	2.43
	Heatwave	Frequent	4	Minor	Moderate	Major	Minor	Negligible	Negligible	Moderate	2.29
	Above average surface temperature	Frequent	4	Negligible	Negligible	Catastrophic	Minor	Minor	Negligible	Moderate	2.14
	Above average precipitation	Frequent	4	Moderate	Minor	Minor	Minor	Negligible	Negligible	Moderate	2.00
	Cold spell	Occasional	2	Minor	Minor	Negligible	Minor	Minor	Negligible	Minor	1.71
	Heavy snowfall	Occasional	2	Minor	Minor	Minor	Negligible	Minor	Negligible	Minor	1.71