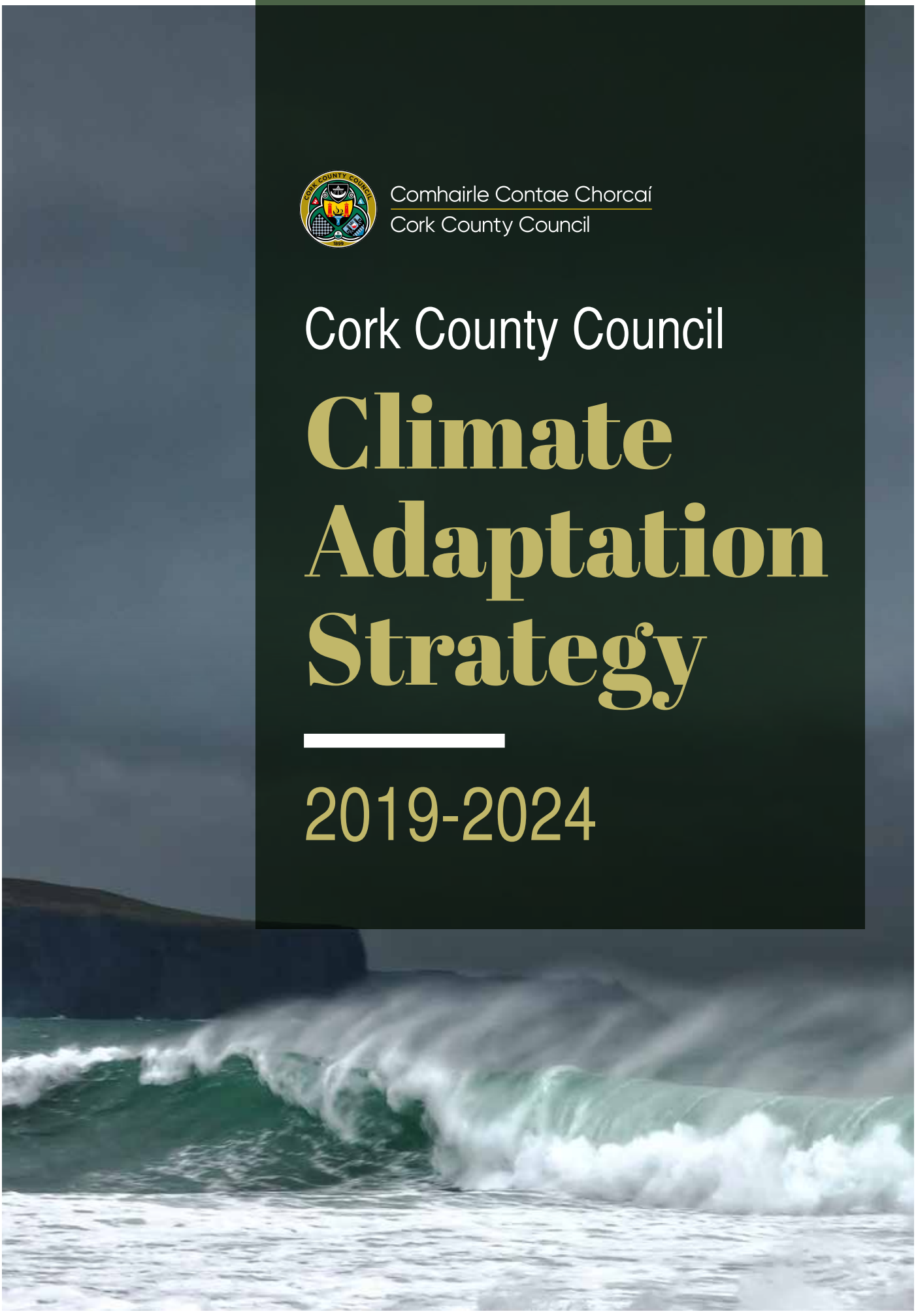


Comhairle Contae Chorcaí
Cork County Council

Cork County Council

Climate Adaptation Strategy

2019-2024

Joint Statement from the Mayor of Cork Cllr Christopher O' Sullivan and Chief Executive Tim Lucey

Climate change is the defining issue of our time and we are at a defining moment. In October 2018, the UN's Intergovernmental Panel on Climate Change (IPCC) produced a landmark report warning the governments of the world that greenhouse gas emissions had to be reduced by 50% within twelve years to prevent "catastrophic and irreversible climate change." Scientists predict that catastrophic climate change will involve widespread destruction of property and infrastructure, major political unrest, mass migrations of climate refugees and the eventual breakdown of our food production systems. These realities are already unfolding in parts of Asia and Africa.

In February 2019 the Council of the European Union stated that "climate change is a direct and existential threat, which will spare no country". According to Kristalina Georgieva, CEO of the World Bank, "We are clearly the last generation that can change the course of climate change, but we are also the first generation with its consequences." Despite such warnings, global greenhouse gas emissions continue to rise. We are currently on a trajectory towards the mass extinction of species, and the potential extinction of the human race. The challenges posed by climate change eclipse all others in human history.

The impact of Climate Change will affect us all and it is a problem which requires commitment from all parties involved, big and small. The All of Government Climate Action Plan commits all sectors to an integrated approach and through the proposed local government charter will commit to ensuring that resources are available for Local Authorities to carry out the required actions. We, as a Local Authority, will have to change and adapt to these new circumstances. The Climate Adaption Strategy is the first step in building the foundations required to enhance resilience to climate hazards. The actions presented in this strategy will guide County Cork to address the challenges and develop innovative and sustainable solutions that address adaptation and enhance resilience to a changing climate.

Cork County Council will play a pivotal role for the county in adapting to Climate Change. We will work through our services delivery and with the people of Cork to ensure we deliver a better future for all.

We will need the support of every sector and community across the county to make real change that will build our new low carbon resilient economy, while delivering on our hopes of creating opportunities for everyone. In particular, as we now provide services that are related to the business of almost all Government Departments, we will need considerable support, both in terms of active leadership and resource facilitation, in order to be able to deliver on our ambition for Cork County. Cork County Council is committed to mainstreaming Climate Change in the delivery of its services and affecting change in terms of climate adaptation.

CATHAOIRLEACH
Christopher O' Sullivan
Cork County Council

CHIEF EXECUTIVE
Tim Lucey
Cork County Council

Executive Summary

Under the National Adaptation Frameworks (NAF), which was published in response to the provisions of the Climate Action and Low Carbon Development Act 2015, all Local Authorities were tasked with producing a Climate Adaptation Strategy for their functional areas. The Environment Directorate of Cork County Council developed the Climate Adaptation Strategy for Cork County. The strategy draws on the data issued by both national and international forums in addition to those from regional and local sources. It establishes an extreme weather event baseline and predicts the challenges and risks that climate change will pose for the county in the future. Furthermore, the strategy proposes a series of actions to adapt to those climatic changes which are already taking place.

The strategy is based on extensive review, research and stakeholder engagement. The public consultation process will also inform the objectives and actions set out in the strategy. Once adopted, the Climate Adaptation Strategy will be the main instrument to achieve the overarching commitment by Cork County Council towards a low carbon, climate resilient and sustainable environment.

A climate risk register has also been compiled as part of this strategy and it aims to identify a set of actions to minimise impacts from extreme weather events. The risk register is informed by the hazards and vulnerabilities associated with climate change across the county.

This Climate Adaptation Strategy is the first of its type for Cork County Council. It is a high-level document designed to mainstream the issue of climate change in Local Authority plans, policies and operations. In order to prepare for the challenges of climate change and adapting to its effects, seven high level goals were identified:

- Local Adaptation Governance and Business Operations
- Infrastructure and Built Environment
- Landuse and Development
- Drainage and Flood Management
- Natural Environment, Built and Cultural Heritage
- Community, Health and Wellbeing
- Other Sectors and Agencies

The development of these high level goals, are supported by a number of objectives and actions that form that basis of the strategy.

Contents

Chapter 01

Introduction

1.1 Background to Climate Change

The Earth's climate is changing and the impact of these changes are becoming increasingly more evident. Such visible climate changes include variations in air and ocean temperatures, accelerated melting snow and ice caps, widespread retreat of glaciers, rising global sea level rise and extensive changes in weather patterns. These changes are creating significant global economic, environmental and social impacts.

Climate change refers to a change in climate patterns, in particular a change apparent from the mid to late 20th century onwards, and attributed largely to the increased levels of atmospheric carbon dioxide (CO_2) produced by the use of fossil fuels, resulting in numerous climatic shifts and impacts around the globe.

Several gases, such as carbon dioxide and methane (CH_4), exist naturally in the atmosphere and contribute to the warming of the Earth's surface by trapping heat from the sun in what is known as the greenhouse effect. When the proportion of such greenhouse gases in the atmosphere is stable, the effect is beneficial, making surface temperatures warmer and alleviating temperature swings. However, human activity is increasing the concentration of greenhouse gases in the atmosphere, which is already causing average temperatures to rise.

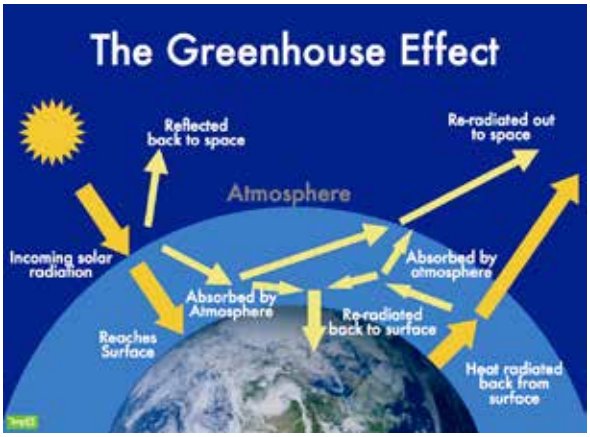


Figure 1.1 Greenhouse Gas Effect [1]

There is broad scientific consensus that human activities, most notably the burning of fossil fuels for energy, have led to the rapid build-up in atmospheric greenhouse gases. The Intergovernmental Panel on Climate Change (IPCC) stated in 2007 that CO_2 levels in the atmosphere rose from a pre-industrial level of 280 parts per million (ppm) to 379ppm in 2005 [2]. This coincided with an increase in the average global temperature of 0.74°C between 1906 and 2005. In 2013, the U.S. National Oceanic and Atmospheric Administration announced that CO_2 levels had reached 400ppm [3]. That same year, the IPCC concluded that "human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes.... it is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century" [4]. In 2012, the World Meteorological Organization [5] released analysis showing that the decade spanning 2001-2010 was the warmest ever recorded in all continents of the globe.

Climate scientists from the UK Meteorological Office expect to see one of the largest global rises in atmospheric carbon-dioxide concentration in 2019 with average levels of CO_2 expected to reach 411ppm [6]. This forecast is based on a combination of factors including rising anthropogenic emissions and a reduction in the uptake of carbon-dioxide by ecosystems due to tropical climate variability [6]. Most recently, the IPPC reported that human activities are estimated to have already caused approximately 1.0°C of global warming above pre–industrial levels [7]. It concluded that if current rates continue, the world would reach a human-induced global warming of 1.5°C by 2040.

Impacts from this global warming are readily observed and include increases in global average air and ocean temperatures, accelerated melting of snow and sea ice, widespread retreat of glaciers, rising global average sea level, and extensive changes in weather patterns, including changes in precipitation levels and increased storm intensity.

Observations show that Ireland's climate is also changing in line with international climate patterns outlined above. Some of the projected physical climate changes include:

- increase in average temperature (surface air temperature, sea surface temperature);
- changes in precipitation patterns;
- ongoing mean sea level rise;
- changes in the character of weather extremes such as storms, flooding, sea surges and flash floods.

1.2 Climate Adaptation Strategy

Climate adaptation planning aims to build climate robust communities, to safeguard people, ecosystems, businesses, infrastructure and buildings from the negative impacts of climate change. As a Local Authority, Cork County Council plays an important role in planning for, and responding to, emergency situations within the county.

This Cork County Adaptation Strategy (2019- 2024) is Cork County Council's first step in the climate adaptation process. This strategy will essentially set out the Local Authority's strategic priorities, measures and responses for climate adaptation in the county over the next 5 years.

Cork County Council provides a wide range of services, many of which are already and will increasingly be affected by climate change. The Local Authority will continue to play a critical role in responding locally to the impacts of extreme weather events and other impacts that are likely to emerge over the coming decades.

This Cork County Council Adaptation Strategy is set against the background of increasing risks associated with climate change and seeks to reduce and manage these risks at local level in all Local Authority activities.

1.3 Climate Adaptation & Climate Mitigation

Mitigation and adaptation are important strategies in responding to climate change and represent two different paths for dealing with climate change. Mitigation deals with the *causes* of climate change and works to reduce man-made *effects* on the climate system. In contrast, climate adaptation refers to actions taken to reduce the negative effects of climate change or to take advantage of emerging opportunities.

The Intergovernmental Panel on Climate Change (IPCC), 2014 [8], define Climate Mitigation as

> **"human intervention to reduce the sources or enhance the sinks of greenhouse gases".**

It essentially refers to efforts to cut or prevent the emission of greenhouse gases thereby limiting the magnitude of future global warming.

The IPPC, in 2013 [9], defined climate adaptation as:

> **"The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects."**

Climate adaptation is essentially a planning mechanism to proactively action and make adjustments to reduce the existing and projected impacts from climate change.

Climate change mitigation and adaptation are not mutually exclusive but are key partners in any strategy to respond to climate change (Figure 1.2). As effective mitigation can restrict climate change and its impacts, it can also reduce the level of adaptation required by communities.

However, there is a significant time lag between mitigation activities and their contribution to climate change reduction. Even if emissions were to be dramatically reduced today, current greenhouse gases in the atmosphere would continue to result in global warming and drive climate change for many decades.

In general, the more mitigation there is, the less will be the impacts to which society will have to adjust, and the less the risks for society to prepare. Conversely, the greater the preparatory adaptation, the less may be the impacts associated with any given degree of climate change.

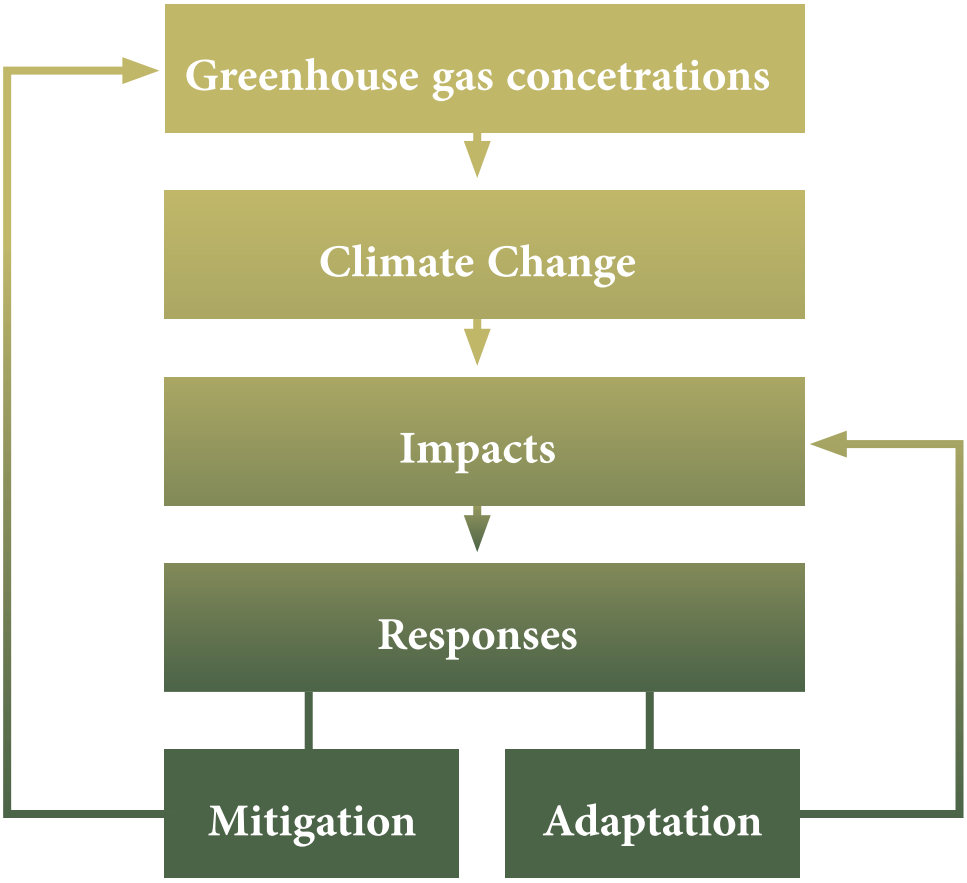


Fig. 1.2 Strategies to address climate change.

1.4 Climate Change Challenge for Ireland and County Cork

A recent Environmental Protection Agency report

"A Summary of the State of Knowledge on Climate Change Impacts for Ireland [10] states that there is "evidence that Ireland is being impacted by global climate change and that projects of future climate change across all scenarios suggest that changes will continue, but uncertainties on details of these for countries such as Ireland remain large".

The impacts of climate change are felt more prominently at a local level. County Cork has experienced severe weather events over recent years including increases in storm events, higher incidences of flooding and periods of prolonged drought. All these events impacted on the lives and livelihoods of County Cork's residents and businesses. A synopsis of these weather events is outlined in Chapter 3.

1.5 Adaptation Policy Context

This Cork County Council Adaptation Strategy is set within a policy framework at International, European and National level.

1.5.1 International & European Context

These International & European Policies and Agreements are outlined in Figure 1.3 below:

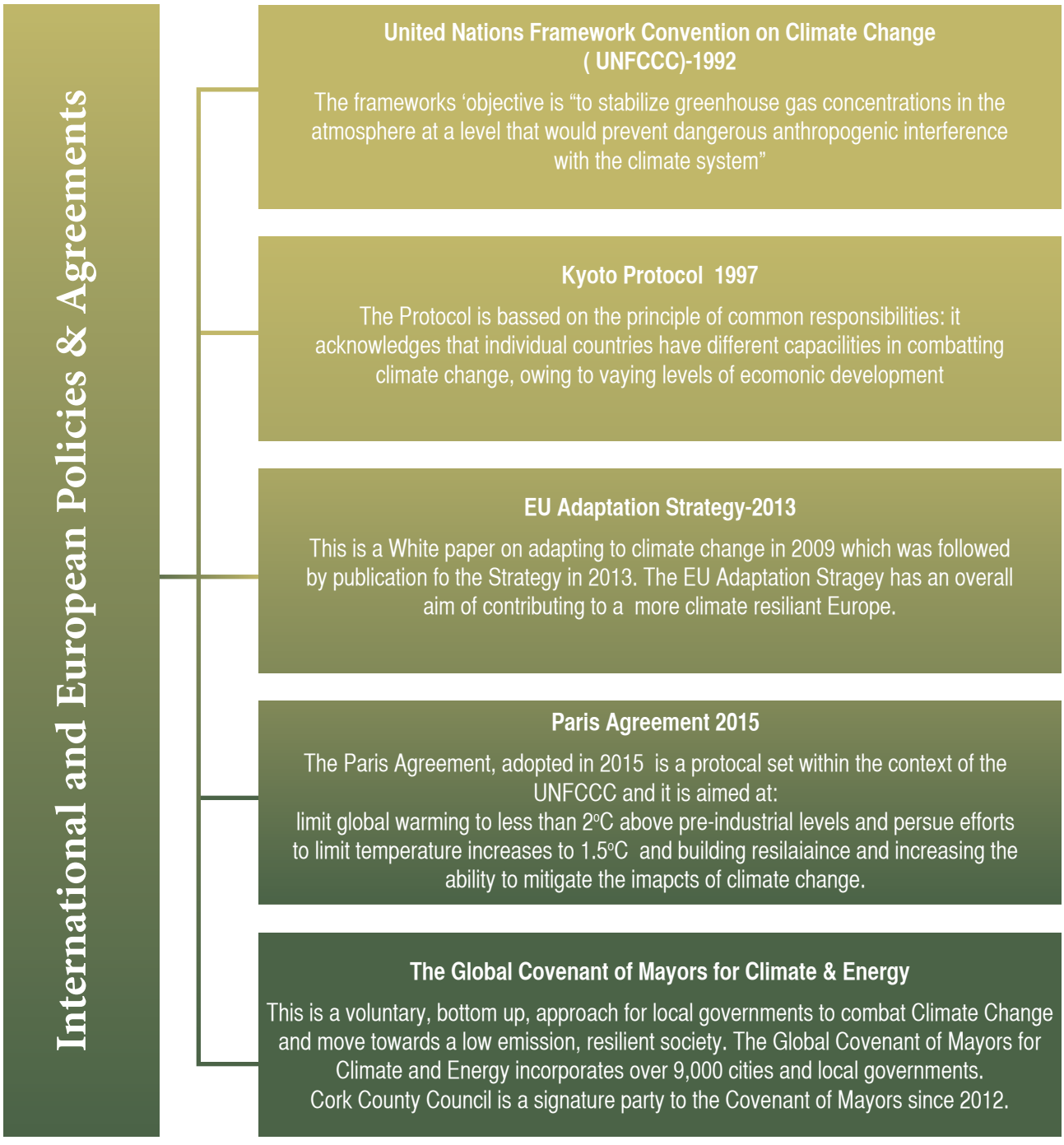


Fig 1.3 International & European policies and agreements

In 2015, countries adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). The SDGs are a blueprint to achieve a better and more sustainable future. They address global challenges related to poverty, inequality, climate action, environmental degradation, prosperity, and peace and justice. The Goals interconnect and are interdependent. Goal No. 13 addresses Climate Action with an objective to:

Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy.

The Goal recognizes Climate Change as a global challenge that does not respect national borders and requires solutions that need to be coordinated at the international level to help developing countries move toward a low-carbon economy. Further, it serves to underpin international, European and National policy context and frameworks that address climate action and pursue efforts to combat climate change.

1.5.2 National Context

At a national level, the National Policy Position on Climate Action and Low Carbon Development (2014) sets out the national objective of achieving a transition to a low carbon economy. This was given legislative effect by the Climate Action and Low Carbon Act 2015. The Act provided for the development of a National Adaptation Framework (NAF), which was published in December 2017. The NAF requires sectoral and local adaptation strategies to be developed.

This adaptation strategy is set within the context of a national framework for adaptation planning which is prescribed in the Climate Action and Low Carbon Development Act 2015 and elaborated upon in the National Adaptation Framework.

This adaptation strategy commits to aligning with national commitments on climate change adaptation. It must be noted that the process of making 8 sectoral adaptation strategies (identified in the NAF) is running concurrently with the making of local authority strategies. Once published, the plans will be assessed against Cork County Council's strategy with a view to identifying common goals and addressing any areas of disaccord. For both the preparation of this strategy and the implementation of actions, opportunities will be advanced in collaboration with adjoining local authorities including Clare, Kerry and Limerick County Councils as well as Cork City Council.

The Local Authority Adaptation Strategy Development Guidelines 2018 provides guidance to Local Authorities to develop their own Climate Action Adaptation Strategy. In developing this adaptation strategy Cork County Council has been consistent with these guidelines.

See outline of all national polices and legislation below:

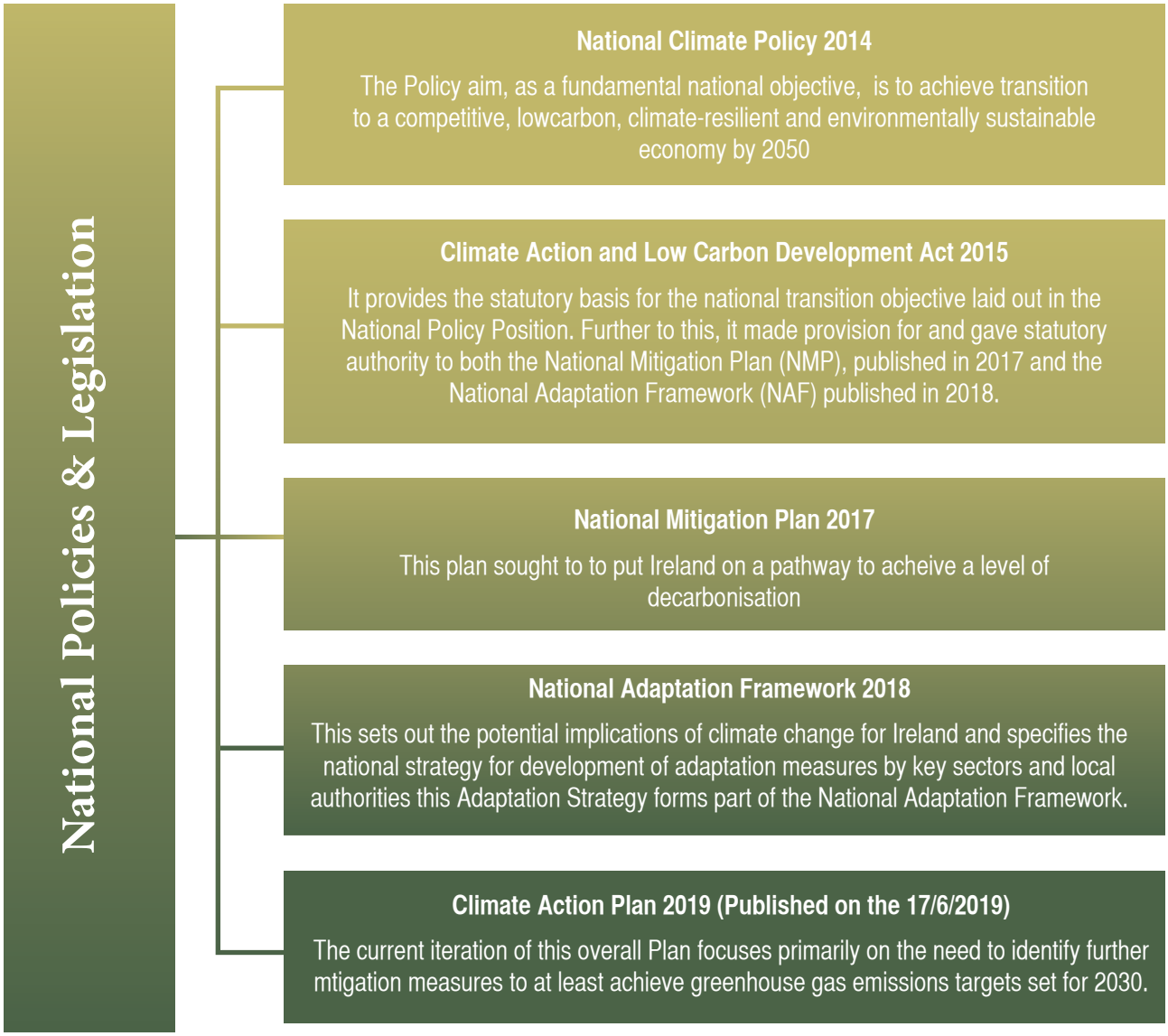


Fig 1.4 National legislation and agreements

1.5.3 Sectoral Context

The National Adaptation Framework (NAF) has also identified twelve sectors across seven Government Departments/ Agencies for the development of Climate Adaptation Strategies. These include actions to be implemented at a Local Government level.

Sector	Parent Department
Seafood	Department of Agriculture, Food and the Marine
Agriculture	Department of Agriculture, Food and the Marine
Forestry	Department of Agriculture, Food and the Marine
Biodiversity	Department of Culture, Heritage and the Gaeltacht
Built and Archaeological Heritage	Department of Culture, Heritage and the Gaeltacht
Transport Infrastructure	Department of Transport, Tourism and Sport
Electricity and Gas Networks	Department of Communications, Climate Action and Environment
Communications networks	Department of Communications, Climate Action and Environment
Flood Risk Management	Office of Public Works
Water Quality	Department of Housing, Planning and Local Government
Water Services Infrastructure	Department of Housing, Planning and Local Government
Health	Department of Health

Table 1.1 Government Departments and Sectoral Plans [11]

1.5.4 Local Context

Again, under the National Adaptation Framework, each Local Authority is required to develop a Climate Adaptation Strategy for the period 2019-2024. The Environment Directorate of Cork County Council has been tasked with developing this Climate Adaptation Strategy for County Cork. These strategies will be used to inform development plans and other statutory plans and policies of the Local Authority in addition to mainstreaming climate adaptation into day-to-day Local Authority operations. The local strategies will also take on board the actions identified in the draft sectoral plans described in Section 1.5.3 above.

This Climate Adaptation Strategy is the primary instrument at local level to:

1. Ensure a proper understanding of the key risks and vulnerabilities of climate change
2. Advance the implementation of climate resilient actions in a planned and proactive manner
3. Ensure that climate adaptation considerations are mainstreamed into all plans and policies and integrated into all operations and functions of the Local Authority

1.6 Methodology

1.6.1 Introduction

This Adaptation Strategy was developed utilising a five step process (Fig. 1.5 below). This was supported by data gathered through a number of initiatives including workshops (outlined below), interviews, literary research and consultation with various stakeholders such as CARO, Elected Members and the Centre for Marine & Renewable Energy in addition to undertaking the statutory environmental assessments. The methodology followed the objectives and processes outlined in the *Local Authority Adaptation Strategy Guidelines* which were published by Department Communications, Climate Action and Environment in 2018.

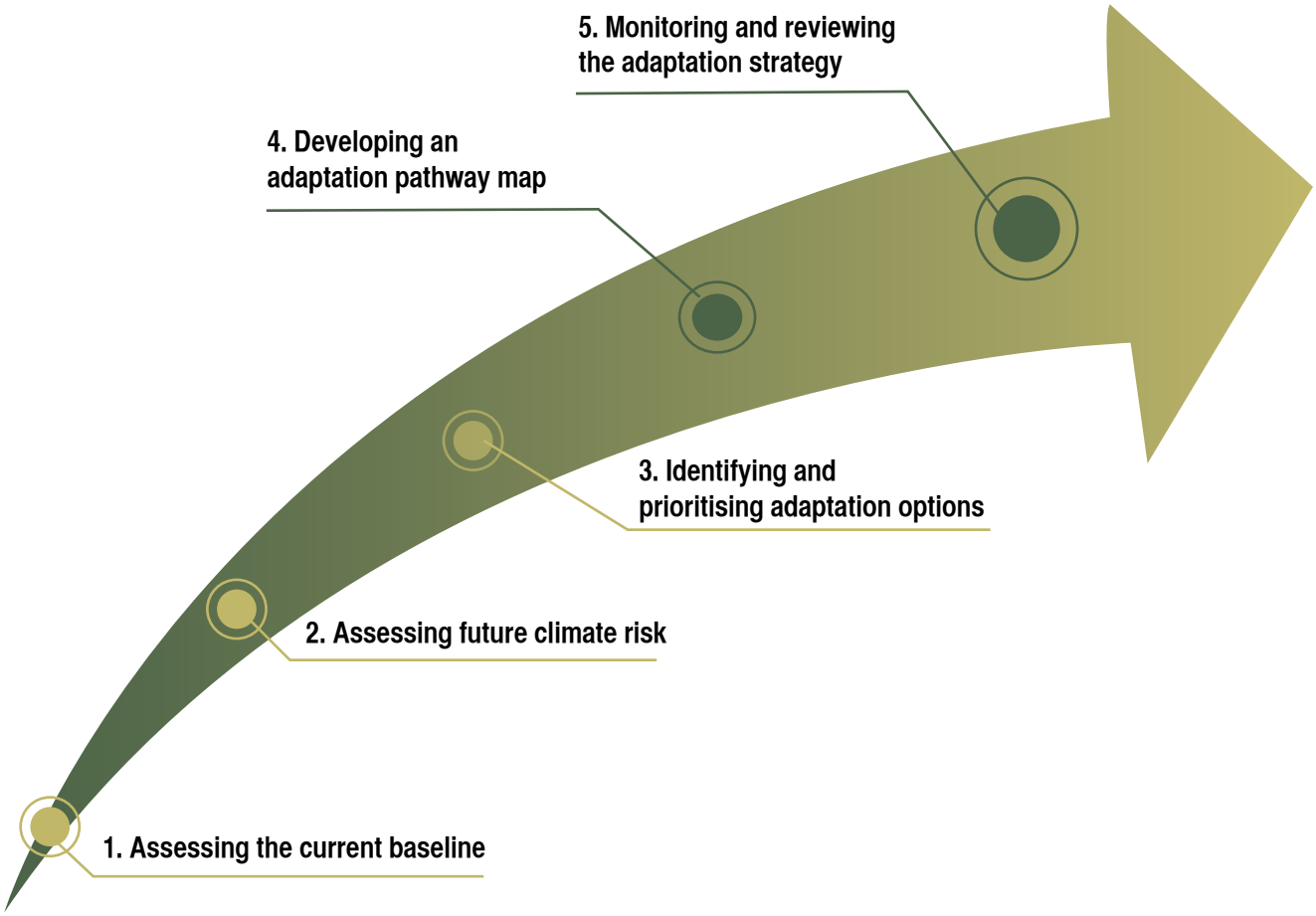


Fig.1.5 Outline of five step process utilised in the development of Cork County Climate Adaptation Strategy

1.6.2 Cork County Council Adaptation Team

In the preparation of this Adaptation Strategy, a multi-disciplined climate adaptation team was assembled across all functions of Cork County Council. This team comprised of staff members from various departments, each with their own expertise and knowledge of climate change effects in their respective areas. A number of workshops and meetings were held to assess Cork County Council's adaptation baseline and identify vulnerabilities and risks to projected climatic events.

In addition to the above, regard was also had to the various Cork County Council policy and planning documents. Other sources of climate related data such as Met Eireann, ClimateIreland.ie, EPA, Centre for Marine and Renewable Energy (MaREI), floodmaps.ie were used to inform the adaptation process.

Pict. 1.1 Cork County Council Climate Adaptation Team Workshop

1.6.3 Environmental Assessment

Screening Overview for SEA:

Under the European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations 2004 (S.I. 435 of 2004 as amended by S.I. 200 of 2011), all plans which are likely to have a significant effect on the environment must undergo screening to determine whether a Strategic Environmental Assessment (SEA) is required. "Screening" is the process for making a determination as to whether a particular plan, would be likely to have significant environmental effects, and would thus warrant SEA. This strategy has been screened for SEA and it is determined that full SEA is not required. The final screening report accompanies this strategy.

Picts 1.2 Some examples of flora and fauna in County Cork that are affected by climate change and subject to AA and SEA screening

Screening overview for AA:

Screening of this strategy has been undertaken in accordance with the requirements of Article 6(3) of the EU Habitats Directive (directive 92/43/EEC) to determine if the Climate Adaptation Strategy is likely to significantly affect Natura 2000 sites (i.e. Special Areas of Conservation (SAC) and Special Protection Areas (SPA)) within or surrounding the plan area. It is determined that stage 2 Natura Impact Report is not required.

The final screening report accompanies this strategy.

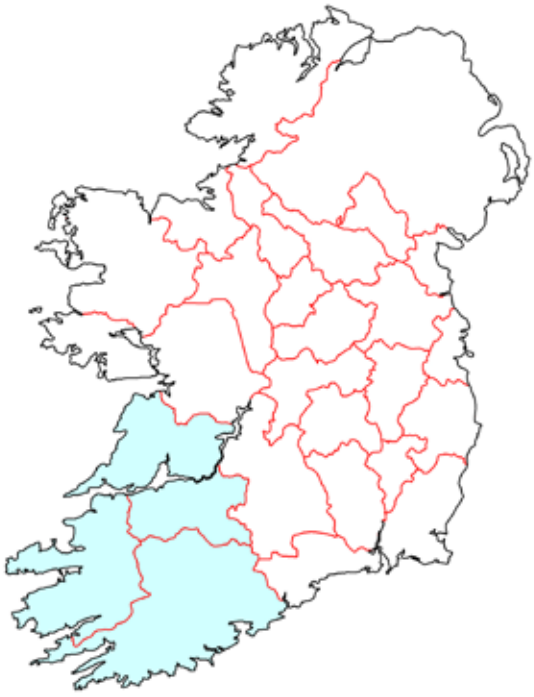
Chapter 02

Regional And Local Context

2.1 Climate Action Regional Office

For the purposes of preparing the Climate Change Adaptation Strategies, the country has been divided into four regions; Dublin Metropolitan, Eastern & Midlands, Atlantic Seaboard South and Atlantic Seaboard North. The regional offices are based on regions which face similar risks from climate change. Cork County Council is one of five Local Authorities in the Atlantic Seaboard South Climate Action Region Office (CARO) and includes the Local Authority areas of Limerick City and County, Cork City, Kerry and Clare.

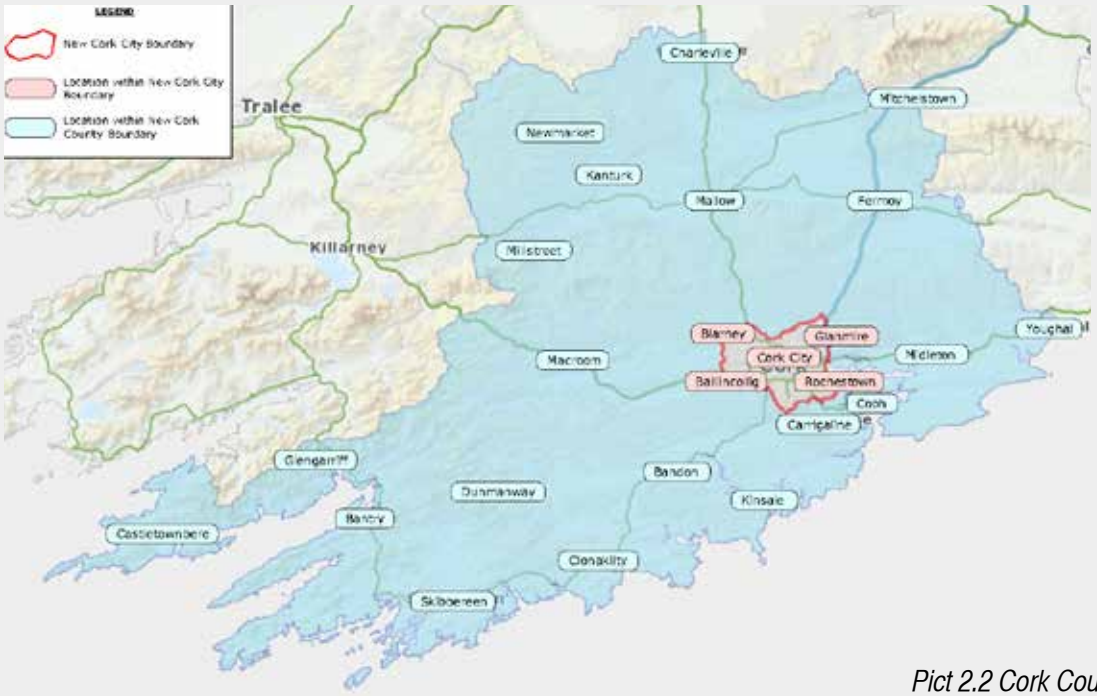
All of the Local Authorities in the Atlantic Seaboard South region face similar risks from sea level rise, coastal flooding, storms, ground water flooding and rural pluvial flooding. The function of the CARO is to assist and coordinate the preparation of county level adaptation strategies. Cork County Council has been appointed as the lead Local Authority for the CARO Atlantic Seaboard South Region



Pict.2.1 Map of the counties in the Atlantic Seaboard South region

2.2 Cork County Profile

Cork County Council is one of the Ireland's largest Local Authorities serving a population of 322,211 (6.81% of the total population) [12] and is responsible for a geographical area of 7,457 km2 (10.6% of total area of the State) [13]. The Cork County Development Plan 2014 [14] identifies 302 designated settlements including towns, villages and 7 Islands in the county. The combined Cork City and County administrative areas are reported to contribute 19% of the National GDP [15].



Pict 2.2 Cork County Profile

The coastline of County Cork extends for 1,118km, which is 20% of that of the country [13]. This coastline is home to 65% of the County's populations who live on or adjacent to the coast [14]. The coastline also contains centres of important economic activity of national significance such as Cork Harbour, Whitegate Oil Refinery, Whiddy Island Oil Trans-shipment Terminal and Castletownbere fisheries port [14]. The coastal region supports many harbours, beaches and biodiversity areas of national importance. Cork Harbour is the most significant port outside of Dublin and has an important role in the leisure, recreation, heritage and tourism sectors in County Cork. Furthermore, there are 27 beaches which have been identified by Cork County Council for annually monitoring and management in line with the Bathing Water Quality Regulations (2000). Of these 27 beaches, 7 have attained the Green Flag status for 2018 while another 13 attained the Green Coast award for 2018 also [15].

The county is mainly drained by the catchments of the Rivers Blackwater, Bandon and Lee, which rise at the west of the county and flow in an easterly direction before turning southward and discharging into the Celtic Sea. The remaining rivers outside of these catchments, such as the Ilen, the Argideen and the Owenacurra generally flow southward to the sea. The county with 7,593 km of river length, accounts for 10% of the total river length of the state [17]. Some of the County's main towns and centres of population such as Bandon, Bantry, Carrigaline, Clonakilty, Skibbereen and Youghal are on or close to the coastline, while inland towns are on or close to the main rivers such as the Blackwater (Fermoy and Mallow) and the Lee (Macroom). The ESB operate one of the Country's largest hydro-power schemes on the River Lee upstream of Cork City with reservoirs and dams at Inniscarra and Carrigadrohid which have a storage capacity of 45 million cubic metres [18].

As well as 6,510 public housing units, the Local Authority owns up to 150 municipal buildings whose functions encompass the full range of local government activity and vary from Area Offices and Libraries to Civic Amenity Sites and Leisure Centres.

The National Road network, which is managed by TII (Transport Infrastructure Ireland), has a total length of 5,306km, of which 445km (8.4%) are in the Local Authority administrative area [19]. Cork County Council has responsibility for the Regional and Local Roads in its administrative area and, with 1,343 km of Regional Roads and 10,053 km of Local Roads [20], has 10.25% and 12.5% by length respectively of the State's Regional and Local Road network. In relation to bridges, there are records for 1,367 bridges on the network, which represents 6.7% of the State's estimated Regional and Local Road bridge stock of 19,000 bridges [21].

With regard to Emergency Services, Cork County Council provides a fire and rescue service from 20 fire stations located throughout the county. There are 11 Upper Tier Seveso Sites and 10 Lower Tier Seveso Sites located in the county [22], the majority located in the coastal areas of Ringaskiddy and Little Island.

In the area of procurement, Cork County Council recognises the importance it plays in the local economy and its obligations to procure goods and services in an environmentally sustainable manner. Cork County Council will continue to support and implement green procurement policies and initiatives in its day-to-day purchasing of goods, services, works and utilities. Such policies include GPP 4 Growth which is an Intereg project bringing together partners from nine countries (including Ireland) to exchange experiences and improve capacities on implementing resource efficiency policies that promote eco-innovation and green growth through Green Public Procurement.

In the case of the natural environment, the National Biodiversity Action Plan for 2017-2021 [23] states that there is evidence that climate change is negatively impacting Irish habitats and is driving ocean acidification. In Cork County there are 30 Special Areas of Conservation, 18 Special Protection Areas, 9 Natural Heritage Areas and approximately 89 proposed Natural Heritage Areas [24]. Expected increases in temperature, changes in precipitation patterns, weather extremes (storms and flooding, sea surges, flash floods) and sea-level rise will affect the abundance and distribution of Irish species and possibly encourage the spread of alien invasive species, noxious weeds and pests. All these protected biodiversity areas will need to be given careful consideration during climate adaptation planning.

Given the size and geographical features of the area as well as the infrastructure assets and responsibilities of Cork County Council, the negative impacts of climate change pose a significant risk to citizens, the economy, the environment and the delivery of local government services. It is therefore imperative to introduce climate adaptation measures as soon as possible.

2.3 Cork County Council Climate Adaptation Case Studies

Cork County Council has already experience in the area of adaptation planning and has been successfully responding to climatic events over recent years. Examples of adaptation initiatives are outlined in this Section.

2.3.1 Barleycove Causeway Temporary Bridge Project

A section of roadway on the causeway located between Crookhaven/Barleycove and Mizen Head was closed due to the subsidence of a bridge structure after a flood/rainfall event in September 2015. The site was particularly difficult in that it was located in a tidal location and also situated within a Special Area of Conservation.

The situation caused disruption to local residents and a permanent replacement project commencing over the summer, with a necessary road closure, would have impacted upon tourist traffic. In an effort to maintain traffic movements across the causeway, Cork County Council explored alternative options of opening the causeway to traffic using a short term temporary solution. A solution was devised for the stabilisation of the existing structure and the installation of a temporary steel bridge which allowed the reopening of the roadway to single line traffic. A temporary bridge (12m span x 5m width), suitable for vehicular traffic was sourced in the UK.

The temporary bridge was put in place in November 2015 which allowed the road to be reopened. This was left in place until the end of the 2016 tourist season. At that point, the temporary bridge was removed and the permanent repair work was carried out. The road reopened to two way traffic in early December 2016. The installation of the temporary bridge had the advantage of facilitating the reopening of the causeway in a matter of a few weeks. At the end of the exercise the temporary bridge ultimately became an asset available to Cork County Council in dealing with future emergency bridge or culvert collapse situations at short notice.

Pict 2.3 Damaged road before temporary bridge

Pict 2.4 Road after temporary bridge installation

2.3.2 Mallow Flood Relief Project

Mallow has a long history of flooding, principally from the River Blackwater, which flows through the town. There are other watercourses including the Spa Glen Stream which also caused flooding problems, as it flows through the town centre, mostly beneath the streets in a series of culverts.

Major floods have occurred in Mallow in 1853, 1875, 1948, 1969, 1980, 1988, 1995, 1998, 2004, 2008, 2009 and 2010. The most severe flood occurred in 1853 when the town bridge was swept away.

A Flood Relief Scheme was undertaken by the OPW from 2008 to 2010 and comprised of new culverts, walls and embankments, demountable defences, pumping stations and the lowering of ground at Mallow Bridge.

Upon receipt of a warning from the Early Flood Warning System developed by the OPW, Cork County Council staff install demountable defences at required locations to retain the flood waters.

At a cost of €36.7M, the Mallow Flood Relief Scheme has been fully operational for over 5 years and has resulted in:

- reduced economic loss to vulnerable traders,
- reduced damage to residential and commercial property,
- reduced social disruption to the local economy,
- reduced disruption and delays to traffic in the town.

Pict. 2.5 Mallow in flood

Pict 2.6 Demountable defense during flood event

2.3.3 Bridge Scour in County Cork

A bridge condition survey, undertaken to Eirspan Bridge Management System standards was carried out by Cork County Council between 2012 and 2014. This survey showed a considerable amount of damage to a number of bridge abutments and piers resulting from scour action. Scour is phenomenon whereby the level of the riverbed becomes eroded due to the action of water flow, leading to the exposure of bridge foundations, as shown in Fig.2.1.

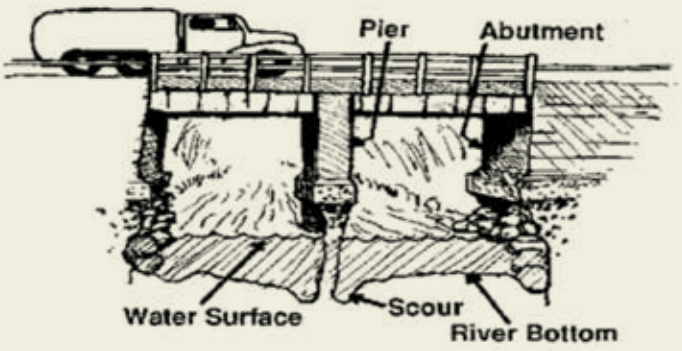


Fig 2.1. Bridge Scour at Pier and Abutment [25]

An analysis of the information from this survey showed that 62% of critically damaged bridges surveyed in County Cork had levels of bridge failure due to scour when compared to 15.51% [26] , 25% [27] and 20.65% [28] from other similar international studies.

The findings concluded that scour was a particular issue in the Cork area and is a significant consequence of climate change resulting from increased rainfall intensity and larger flows. Following on from this survey, remedial works were carried out on a number of bridges and associated structures in County Cork. An example of this is on the L6822 Ballygrogan Bridge, Rathduff, where a floor slab and scour skirts were constructed to re-strengthen the bridge and to alleviate future damage from scour action.

Pict 2.7 Scour damage on Ballygrogan Bridge

Pict 2.8 New bed and scour skirts installed

2.3.4 Garrettstown Beach Coastal Protection Works

Garrettstown beach is located approximately 9km south of Kinsale. This location consisted of sea walls, gabion baskets, rock armour and embankments all performing as coastal protection measures. During the storms of 2014, however, the gabion baskets suffered severe damage and alternative coastal protection measures had to be investigated.

In June 2017, an ECAB (Erosion Control Armour Block) coastal protection system was installed by Cork County Council to address the issues with coastal erosion and flooding at this location. The ECAB is manufactured from a blend of Ordinary Portland Cement (OPC) and Ground Granulated Blast Furnace slag (GGBS). This system allows the concrete to achieve a lighter colour finish; it is a more environmentally friendly, stronger and a more durable concrete. The lighter colour allows the ECAB blocks to match the local sands and the voids allow indigenous vegetation such as marram grass to grow between the blocks to enhance their aesthetic and biodiversity appeal.

This ECAB revetment was designed primarily to protect the regional road (R604) from being overtopped. Overtopping resulted in sand and other beach debris being strewn across the road thereby limiting traffic movements in the area. During winter time this was a common occurrence and the road was cleared repeatedly by Cork County Council at considerable expense. The ECAB revetment has also been shown to be extremely stable when tested during storms when compared to the traditional rock armour boulders which can be displaced in similar conditions.

Pict 2.9 Garretstown Beach after storm & before coastal works

Pict.2.10 ECAB revetment in place at Garretstown beach

2.3.5 Energy Management System in Cork County Council

Under the National Energy Efficiency Action Plan (NEEAP), Cork County Council has been set an energy efficiency improvement target of 33% on 2009 energy efficiency figures by 2020. To date an improvement of 20.8% has been achieved. Ireland's second National Energy Efficiency Action Plan to 2020 (NEEAP II) gives an exemplar role to Local Authorities which includes local authorities with an energy spend of greater than €5million to become ISO 50001 Compliant.

ISO 50001 is based on the management system model of continual improvement also used for other well-known standards such as ISO 9001 or ISO 14001. In May 2016, Cork County Council became the first Local Authority in Ireland to achieve ISO 50001-2011 certification for its Energy Management System and repeated the feat in 2019 by becoming the first Local Authority to become ISO 50001-2018 certified. The benefit of certification is having a structured energy management system, promoting awareness among staff and encouraging a culture that champions best practice. The data collated as part of this system can also assist in establishing baseline energy information in the context of this strategy and in developing a system to monitor energy reduction progress.

In 2018, public lighting accounted for 54% of energy use within the Local Authority (Fig 2.2). With that in mind Cork County Council is participating in an ambitious national Public Lighting Energy Efficiency Project which aims to retrofit approximately 30,000 lights across Cork County. Once complete this will have a major impact on the Local Authority's overall energy use and assist in achieving energy reduction targets.

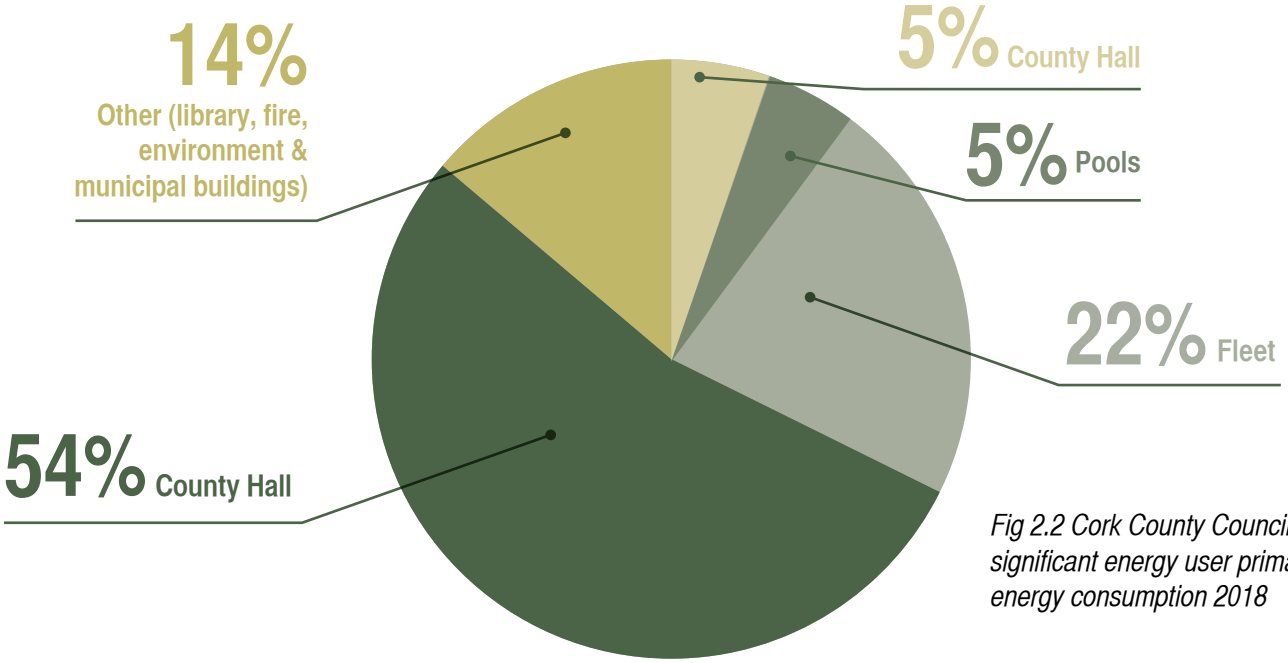


Fig 2.2 Cork County Council's significant energy user primary energy consumption 2018

Chapter 03

Adaptation Baseline Assessments

3.1 Introduction

The purpose of the baseline is to understand the challenges of current climatic hazards. A review of recent climate events help local authorities anticipate and prepare for future extreme weather events. This process is critical in developing the climate adaptation strategy as it responds to the effects of climate events at a local level.

3.2 Baseline Assessments

A review of climate events that have affected County Cork was undertaken using Met Éireann data [29] along with data gathered from workshops and local research. This is not a complete listing but is intended to give an idea of extreme weather events with which Cork County Council has dealt with in the recent past.

With all climate events comes an understanding of the level of unpredictability. Nevertheless, knowledge and experience acquired from past events (including information from many sectors eg Met Eireann, OPW etc) will benefit future planning and preparedness and a continuous review of extreme events will help to build resilience and prevent the worst of risks.

Extreme weather events	Description
Coastal flooding	• February 2002: Cork City Flooding
Coastal storms	• February 1990: Severe gusts and heavy rainfall • January 1993: Severe gusts and heavy rainfall
Extreme heat	• Summer 1995: Warmest weather since 1955 • Summer 2006: Warmest weather since 1995 • Summer 2018: High temperature & drought conditions
Extreme rainfall	• November 2009: 55mm 1-day total recorded in Baile Bhuirne • June 2012: 58mm 1-day total recorded in Bandon
Fluvial flooding	• November 2000: River Lee • August 2008: River Blackwater • November 2009: River Lee • February 2014: River Lee • December 2015: River Bandon
Freezing conditions	• December 2010: Cork recorded -7.2 degrees • March 2018- Storm Emma- -7.0 degrees recorded at Cork Airport
Groundwater flooding	• January 2016: N25 flooded between Killeagh and Castlemartyr
Heavy snowfall	• January 1987: 12cm of snow at Roches Point • March 2018: 14cm of snow at Cork Airport- Beast from East & Storm Emma
Pluvial flooding	• June 2012: Douglas • August 1997: Freemount
Storm force winds/ windstorms	• February 1988: Gusts in excess of 84 Knots recorded at Cork Airport • January 1991: Gusts in excess of 68 knots recorded at Roches point • October 2017: Hurricane Ophelia.

Table 3. 1 Extreme weather events in Cork 1987-2018

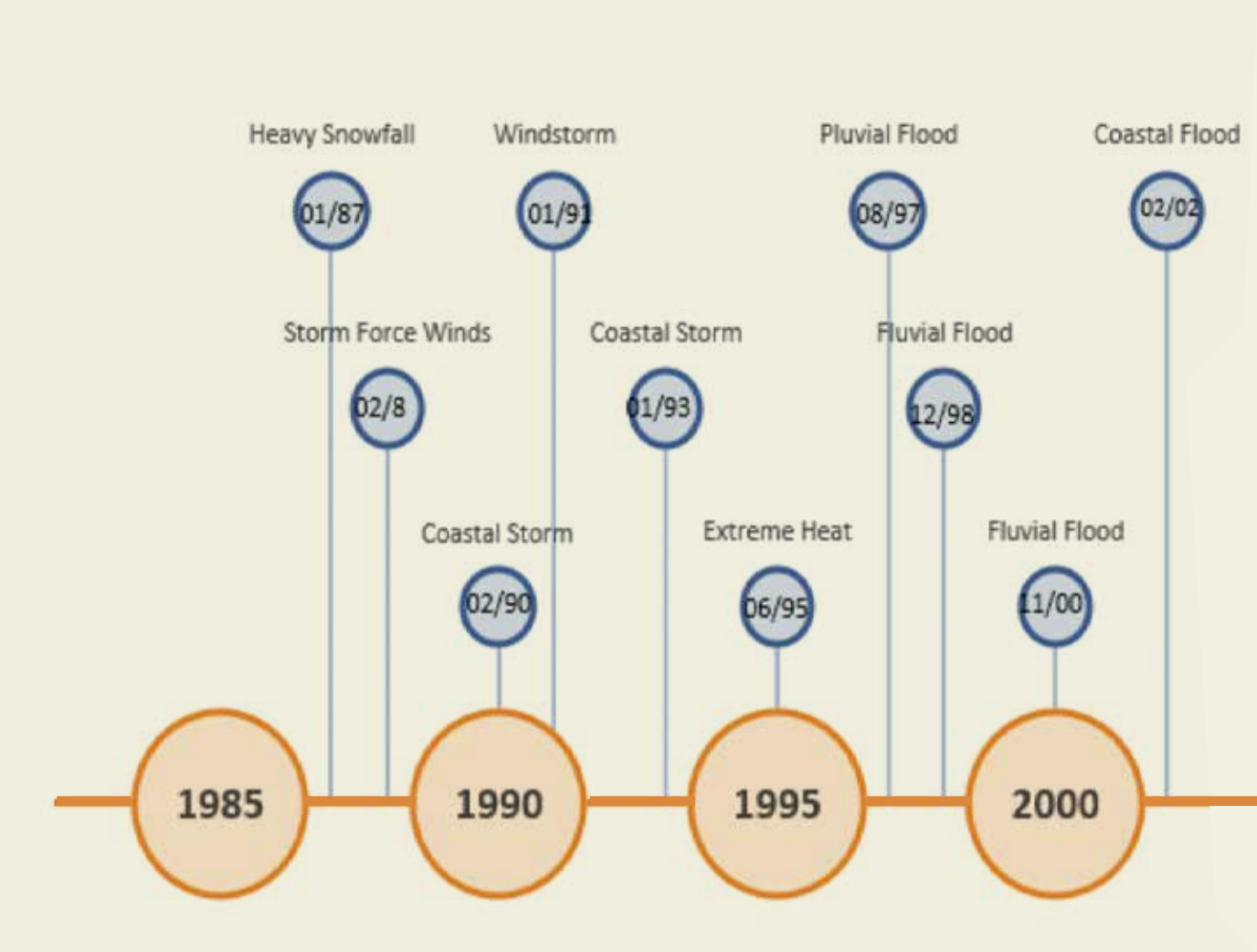
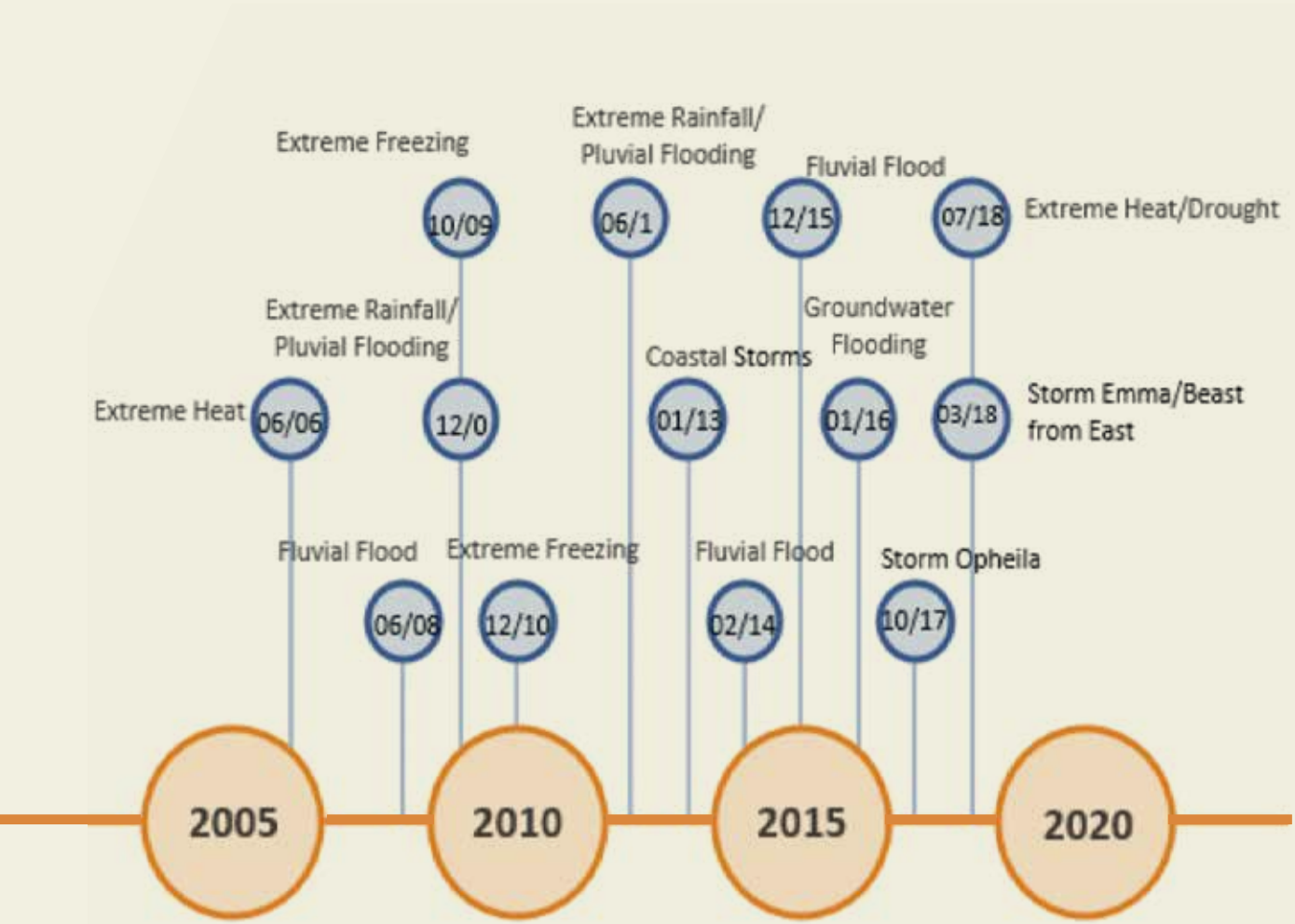


Fig 3.1 Extreme weather events in Co. Cork 1987-2018



Having regard to Table 3.1 and Fig 3.1 and above, it is evident that the main category of extreme weather events has been flooding (coastal, fluvial and pluvial), with fluvial being the most common. This is followed by windstorms and coastal storms and there is a general similarity in the numbers of the remaining event types.

In accordance with the National Framework for Major Emergency Management [30], Cork County Council has a comprehensive Major Emergency Plan in place to ensure that staff at all levels are aware of their responsibilities and that appropriate actions are initiated in a timely and effective manner to deal with major emergencies. The Plan, which describes actions required in the event of severe weather and flood events, has come into operation on a number of occasions, with the most recent activations being Hurricane Ophelia in October 2017 and Storm Emma in March 2018.

Chapter 04

Climate Risk Identification

4.1 Identification of Climate Risk

In identifying climate risk, it is important to realise that risk is based on projections and therefore requires regular updating. The main climate related risks are outlined below and the following is an account of possible effects on key operational areas of the Local Authority as set out in the Local Authority Adaptation Development Guidelines [11]. In terms of assessing how such events affect operational areas of Cork County Council, some examples are included.

4.2 Climate Variables and Climate Risk

Based on available sources, observed and projected changes in seven climate variables have been investigated. They are summarised below, with future climate risks identified:

4.2.1 Hydrology	
Observed	The analysis of river flows is complex and subject to large variability and as a result, it is difficult to identify impacts of climate change. For Ireland during the period 1954 to 2008, summer mean flows were dominated by decreasing trends, while for winter there is a tendency for increases in mean flows. Annual and winter high flows are also dominated by increasing trends [31]. Drier summers could have effects on summer base-flows of rivers in Cork and recharge of underlying aquifers. This ultimately has implications for the provision of drinking water as was evident in many parts of the county during the prolonged drought period in Summer 2018.
Projected	Changes in temperature and precipitation will affect hydrological response. Due to the uncertainties associated with projected changes in precipitation, projected changes in hydrological response remain subject to a high level of uncertainty. The response of individual catchments will be determined by individual catchment characteristics (e.g. groundwater versus surface water dominated catchments). For example, summer reductions for groundwater dominated catchments are not as severe as those projected for surface water dominated catchments [32]. Using runoff impact models a robust indication of increasing seasonality in hydrological regimes is evident with increases in winter and spring stream flow likely and a decrease in summer. A 20% increase in the amount of water flowing during winters through rivers are expected for the majority of catchment by mid-late century while for summer, decreases of over 40% (those with little groundwater storage in particular) have been simulated for the end of the century [32][33]. Projected increases in winter flows coupled with likely increases in extreme precipitation events are likely to lead to an increased flood risk. However, catchment response time will be critical in determining the changing nature of extremes and catchments with fast response times are likely to be most at risk.

Summary of Change	Increasing seasonality in hydrological regimes is expected with decreased summer and increased winter flows likely. Flood risk will increase due to a combination of higher river flows and increases in extreme precipitation events. This is referred to as “combination events” and are likely to play a greater role in climatic events in the future. One example of this is high tides coupled with fluvial and pluvial events especially in the lower reaches of the Lee and Lower Harbour. This would have specific effects in settlements such Cork City and its environs.
Climate Risks Identified	Groundwater flooding, which is the emergence of groundwater at the surface away from river channels and watercourses, under conditions where the ‘normal’ ranges of groundwater level and flow are exceeded. This is likely to be exacerbated in areas along the estuary where ground water is subject to tidal influence. Pluvial, or surface-water flooding, which results from rainfall-generated overland flow, which may occur during or immediately after intense rainfall events and before the runoff enters a watercourse or drainage system. This was evident in Douglas in 2012 and Freemount in August 1997. Fluvial or river flooding, which occurs when excessive rainfall causes a river to exceed its capacity. This was evident in Cork City environs with the River Lee exceeding capacity in 2000 and 2014 and elsewhere in the County, the River Bandon in 2015 and River Blackwater in 2008.

4.2.2 Rainfall

Observed	Throughout Ireland, annual average rainfall amounts have increased, by roughly 5 %, relative to the 1961-1990 baseline period with this increase observed across all seasons. However, spatially, rainfall intensity and amounts vary with no clear direction of change yet apparent [34]. Severe rainfall events have had significant local effects in County Cork, such as 55mm 1-day record measured in Baile Bhuirne in November 2009 and 58mm 1-day record measured in Bandon in June 2012.
Projected	Precipitation projections are less certain than those for temperature and when examined on an individual basis, climate models indicate differing temporal and spatial patterns. However, the projections provide a robust indication of increased seasonality with wetter winters and drier summers likely [35] [36] [37] [38]. For spatial variations, there is a level of disagreement between individual climate models and as a result spatial details are not deemed reliable [38]. As global temperatures increase, the hydrological cycle is expected to become more intense and will result in more extreme precipitation events [4]. For Ireland, projected changes in the frequency of very wet days (>20mm of precipitation) indicate a marked increase for winter (approximately 20%) [38].

Summary of Change	Increasing seasonality in precipitation can be expected with drier summers likely. An increase in the occurrence and magnitude of extreme rainfall events is also likely.
Climate Risks Identified	Groundwater flooding Pluvial flooding Fluvial flooding

4.2.3 Sea Level Rise

Observed	Observations indicate that sea level around Ireland has risen by approximately 3.5cm a decade since the early 1990s, which means an increase of up to 7.0cm between 1990 and 2015 [39].
Projected	An increase in global sea levels is projected suggest in the range of 0.26 to 0.55m for the low emissions scenario and 0.52 to 0.98 for the high emissions scenario [4]. However due to an as yet limited understanding of some of the important effects that contribute to rates of increase, a best estimate for sea level rise cannot be provided with confidence, and estimates of up to 4 to 6 m have been projected by some models [40]. The trend is likely to accelerate over the coming years with projected increases of 81 cm by the end of the century [9]. With 65% of Cork county's population living on or adjacent the coast, Cork is particularly vulnerable [14].
Summary of Change	Sea levels are expected to increase for all Irish coastal areas.
Climate Risks Identified	Coastal flooding, which occurs when normally dry, low-lying land is flooded by seawater. Coastal erosion, which is the process of wearing away material from the coastline due to imbalance in the supply and export of material from a certain section. It takes place in the form of scouring at the foot of cliffs or sand dunes and results in coastline retreat. It is recognised that coastal systems and sediment dynamics will be altered by climate changes. Projected increases in storms and changes in wave action will result in increased levels of coastal erosion, transportation and deposition of sediments.

4.2.4 Sea Temperature	
Observed	The seas around Ireland have been warming at a rate 0.60 C per decade since 1994, which is unprecedented in the 150 year observational record. The greatest warming has been observed over the Irish Sea [41].
Projected	In line with global changes, the seas around Ireland are projected to continue warming over the coming decades. Projected changes for the Irish Sea indicate a warming for all seasons with the highest warming in Autumn and the lowest in Spring [30]. However, due to a limited number of climate model projections, projected changes remain uncertain. With increasing atmospheric CO2, ocean acidity is projected to increase with potential impacts on the marine food webs.
Summary of Change	In line with global trends, the seas around Ireland are expected to continue warming.
Climate Risks Identified	Coastal flooding Coastal erosion Effects on marine bio-diversity

4.2.5 Surface Air Temperature	
Observed	Observations indicate an increase in the surface temperature for Ireland of 0.8°C since 1900. In addition, the number of warm days has increased while the number of frost days has decreased [42].
Projected	Mean air temperatures are expected to increase everywhere and for all seasons relative to the present [38]. With increasing air temperatures, an increase in the intensity and duration of heat waves is expected, with a coincident decrease in the occurrence of frost days likely [38]. Projections indicate that the warmest 5% of daily maximum summer temperatures (TMAX 95%) are expected to increase more strongly than those of average seasonal temperatures with most regions experiencing an increase in TMAX 95% of 0.7 to 2.6°C [38].

Summary of Change	Surface air temperatures are expected to increase everywhere compared to the present An increase in the intensity and duration of heat waves is expected
Climate Risks Identified	Heat waves (defined by the UK Met Office as when the daily maximum temperature of more than five consecutive days exceeds the average maximum temperature by 5°C, the normal period being 1961-1990) [43]. These may lead to severe drought and violent thunderstorms that impact upon human health, physical infrastructure, and river water levels, and may cause forest fires. Higher temperatures and more hot days could result in heat exhaustion and increased heat-related stress, with vulnerable people within communities increasing the need for emergency response. Remote communities are particularly vulnerable. More climate extremes –changes in rainfall variability and increased frequency of heatwaves will impact on native species, encourage diseases, noxious weeds, pests and invasive species, which will need to be managed appropriately. Freezing conditions: fewer frost days and milder nighttime temperatures are expected. One benefit might be a longer growing season, which might suit agricultural production.

4.2.6 Waves and Surges

Observed	Analysis of satellite data for the period 1988 to 2002 shows a general increase in wave height in the northeast Atlantic [44].
Projected	Projections indicate an increase in the occurrence of coastal storms and surges in spring and winter for all areas of the Irish coast with the exception of the southwest. However, confidence in these projections is limited due to a limited number of climate models [45] [46].
Summary of Change	The magnitude and intensity of storm wave heights are expected to increase for spring and winter
Climate Risks Identified	Coastal flooding Coastal erosion.

4.2.7 Wind	
Observed	For Ireland, observations indicate a high degree of yearly variability in wind speeds and, due to a lack of correlation in the available data, analysis of long term trends cannot yet be determined with confidence [47].
Projected	Due to a limited number of climate model projections for wind speed, predictions remain uncertain and further work is required to increase confidence in their outputs. Nonetheless, available projections which focus on 60m wind speeds, the typical height of wind turbines, indicate an increase in wind speeds during winter and a decrease during summer (3-15% reduction) [35][36][37]. As a result of changes in the development regions and tracks of tropical cyclones, a decrease in the frequency of extreme wind storms affecting Western Europe is expected. However, projections indicate an increase in the intensity of extreme wind storms [38].
Summary of Change	Projections indicate a decrease in wind speeds for summer and increases for winter. An increase in the intensity of extreme wind storms is expected.
Climate Risks Identified	Wind storms or High winds, that are defined as a having a wind speed greater than 50 km/h which equates to a Force 7 (28–33 knots) on the Beaufort wind force scale.

4.3 Climate Change Risk Prioritisation

The future climate risk is calculated by combining the projection confidence (i.e. the level of confidence attributable to projections of change in the climatic variable) with the future impact consequence (i.e. the estimated future level of service disruption caused) [48]. A notional scale is developed for each parameter as shown in matrix format in Table 4.1 and the future climate risk is calculated using the equation:

Future climate risk = Projection Confidence X Future impact consequences

		PROJECTION CONFIDENCE				
		LOW 1	LOW/ MED. 2	MEDIUM 3	MED./HIGH 4	HIGH 5
FUTURE CONSEQUENCE	NEGLIGIBLE 1	1	1	1	1	2
	MINOR 2	1	1	2	2	3
	MODERATE 3	2	2	3	3	4
	MAJOR 4	3	3	4	4	5
	CRITICAL 5	4	4	5	5	5

Table 4.1 Climate Risk Matrix [44]

Calculation of the future climate risk for each variable allows the ranking and prioritisation of risks as shown in Table 4.2. The future risk priorities are given scale values with the following definitions [48]:

Projection Confidence Ranking	Future Consequence	Definition
5	Critical	Must not be accepted as part of routine (unadapted) operational procedures; urgent attention at the most senior level required; adaptation measures that function to diminish risk must be proposed and acted on immediately.
4	Major	May be accepted as a part of routine operations only where adaptation measures have been identified and are immediately feasible, monitoring/early warning of the risk is routine and the nature of risk is well understood; senior management must be informed of the status and evolution of the risk over time.
3	Moderate	May remain part of routine operations, but a schedule for future adaptation should be in place, with a thorough investigation of any lead time and/or required precedent steps prior to adaptation measures becoming feasible having been conducted.
2	Minor	Likely to remain part of routine operations; should be assigned a monitoring and observation protocol; existing controls are sufficient and no further action will be required unless significant change occurs
1	Negligible	No further action will be required in the short term unless significant change occurs in the climate variable or receiving environment in question.

Table 4.2 Future climate risk definitions [48]

Using the matrix in Table 4.1 and definitions set out in Table 4.2, a prioritisation of future climate risks was identified for County Cork which can be seen in Table 4.3 below:

Future Climate Risk	Projection Confidence	Future Consequence	Future risk priorities
Fluvial flooding	4	5	5
Heat waves	5	4	5
Coastal flooding	4	4	4
Pluvial flooding	2	5	4
Wind storms	3	4	4
Groundwater flooding	1	4	3
Coastal erosion	2	4	3
Freezing conditions	5	1	2

Table 4.3. Prioritisation of future climate change risks in County Cork

These projections signal significant challenges for the Council, the county, and its citizens. Climate Change will have further effects on land use including agriculture and forestry, on biodiversity, on water resources, human health, the economy and society.

4.4 County Cork Risk Register

The hazards and consequences of extreme climate events forms the basis for the risk register, which under the headings below, summarises the services and business functions impacted:

Local Adaptation Governance and Business Operations			
Services & Functions Affected	**Climate Events**	**Climate Hazard Impacts**	**Consequences**
Business Services	Storm Events, Snow Events, Extreme Rainfall Events	Building closures Electrical faults Risks to staff welfare, Public safety Tourism	Economic Loss

Infrastructure and Built Environment			
Services & Functions Affected	**Climate Events**	**Climate Hazard Impacts**	**Consequences**
Roads, footpaths, bridges, construction and maintenance	All Extreme Weather Events	Increasing deterioration Collapsing infrastructure Impassable areas	Economic Loss Public Safety
Building Stock – LA Buildings and social housing stock	Storm, Rainfall, Snow and Heatwave Events	Housing stock damage Heating issues Closure of Local Authority buildings	Economic Loss Public Safety
Community Infrastructure	Sustained Extreme Events	Weakening of community infrastructure Impacts on recreation amenities and tourism activities	Economic Loss Social Loss Public Safety
Cultural & Heritage	Storm, Rainfall, Snow Events	Damage to cultural and heritage assets	Economic Loss, Environmental & Heritage Loss

Landuse and Development			
Services & Functions Affected	**Climate Events**	**Climate Hazard Impacts**	**Consequences**
Spatial Planning and land use	All Extreme Weather Events	Uncertainty in long term landuse planning infrastructure suitability	Economic Loss Social Loss

Drainage and Flood Management			
Services & Functions Affected	**Climate Events**	**Climate Hazard Impacts**	**Consequences**
Stormwater /sewerage	Storm Surge/ Rainfall Events/ Drought Events	Accumulation of stormwater Increasing pressure on infrastructure Drought events reduce sewerage flows	Economic Loss Environmental & Heritage Loss
Wastewater	Rainfall/Heatwave Events	Inflow and infiltration to wastewater network Interruption to anaerobic process	Economic Loss Environmental & Heritage Loss
Water Supply	Heatwave Events/ Drought/ Rainfall Events/ Storm	Increase in water demand Reduced availability of water supply sources Increased potential for water contamination Quality of water diminished	Economic Loss Social Loss Environmental & Heritage Loss Public Safety
Water Quality	Sustained High Temperatures/ Rainfall Events/ Low Rainfall Events	Changes in species distribution and phenology of river systems Deterioration of water quality	Economic Loss Environmental & Heritage Loss Public Safety

Natural Environment, Built and Cultural Heritage			
Services & Functions Affected	**Climate Events**	**Climate Hazard Impacts**	**Consequences**
Biodiversity	Sustained High Temperatures/ Rainfall Events/ Low Rainfall Events	Changes in the distribution of flora and fauna species Elevated risk of disturbance to population Possible extinction. Reduction in ecosystem	Economic Loss Social Loss Environmental & Heritage Loss

Community , Health & Wellbeing			
Services & Functions Affected	**Climate Events**	**Climate Hazard Impacts**	**Consequences**
Community Development	Extreme Rainfall Events/Sustained Heatwave Events	Increased isolation Damage to properties, streetscapes and community assets.	Economic Loss Social Loss Public Safety

Chapter 05

Adaptation Goals, Objectives and Actions

5.1 Introduction

Based on the risk register and the priority risks categorised by Cork County Council, seven high level goals were identified. A synopsis of the objectives under each goal is provided hereunder:

1 Local Adaptation Governance and Business Operations

GOAL:

To support implementations of adaptation planning in all Council activities and operations. To build resilience within Cork Co Co to support service delivery

2 Infrastructure and Built Environment

GOAL:

To increase resilience of roads and transport infrastructure and of Council owed assets housing stock

3 Landuse and Development

GOAL:

To integrate climate action considerations into landuse planning

4 Drainage and Flood Management

GOAL:

To adapt to the increased risk and impact of flooding. To liaise and work with other bodies responsible for management of water resources

5 Natural Environment, Built & Cultural Heritage

GOAL:

To develop approaches to protect the natural and key cultural assets in Cork County Council

6 Community, Health & Wellbeing

GOAL:

To build capacity & resilience within communities in regard to climate adaptation

7 Other Sectors & Agencies

GOAL:

To collaborate with other Sectors and Agencies in programs relating to climate action and adaptation planning

5.2 Guiding Principles

The seven goals have been developed with the following four guiding principles, to ensure an understanding of the role of adaptation and that a coherent approach to the impacts of climate change is considered in the service delivery of Cork County Council.

Mainstream Adaptation

That climate change adaptation is a core consideration and is mainstreamed in all services and activities across the Local Authority. Additionally, it aims to ensure that the Local Authority is well positioned to benefit from economic development opportunities that may emerge due to a commitment to a proactive climate change adaptation and community resilience.

Informed Decision Making

That effective and informed decision making within the Local Authority is based on reliable and robust information having regard to key impacts, risks and vulnerabilities of the county. This will support long term financial planning, effective management of risks and help to prioritise actions.

Building Resilience

That improved awareness and appreciation of climate change will encourage communities to adapt to the anticipated impacts and promote a sustainable and robust action response and that the needs of vulnerable communities are prioritised and addressed.

Capitalising on Opportunities

Predicted climate change can sometimes result in additional benefits and opportunities for the county. A register of opportunities will enable the Local Authority to encourage communities and interested parties to collaborate on the potential benefits of climate change.

5.3 Climate Change Actions

Cork County Council will address its climate adaptation responsibilities through the following measures:

- Ensuring the effective and efficient delivery of services under changing climatic conditions
- Continue to integrate mitigation and adaptation strategies into all policy and decision making
- Respond effectively to emergency situations and extreme weather events
- Manage climate risks to public assets owned/managed by the Local Authority
- Integrate and implement cross-sectoral adaptation strategies at a local level
- Work with communities to build resilience and adaptive capacity

The actions were developed from interactions with the Local Authority and interested parties through workshops, meetings and research conducted on a national and local level. These actions* which may involve a mixture of grey, green, and soft measures covers all functional/ operational areas of the Council. Each high-level goal can involve a number of Local Authority services and directorates. The Environment Directorate will coordinate the activities of all sections of the Local Authority and will monitor progress.

*Adaptation Options come in many forms and can be usefully characterised as:

- Grey Actions: Technological and Engineering Solutions
- Green Actions: Ecosystem-based approaches that use the multiple services of nature
- Soft Actions: Managerial or Legal Approaches.

The timeframes associated with each action is set out below:

Timeframe	Categorisation
Short	1st Half of Strategy
Medium	2nd Half of Strategy
Long	During & After Lifetime of Strategy

Table 5.1 Timeframe for actions over lifetime of strategy

It should be noted that while some actions can be implemented as proposed, others will need further preparatory work and new budgets prior to implementation. The actions may also change to include sectoral actions as they become available from various central government departments.

5.4 Cork County Council Adaptation Actions

Local Adaptation Governance and Business Operations

Objective: To support the successful and practical implementation of adaptation planning				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
1	Establish a Climate Action Steering Group with senior representatives from the key functions of the Local Authority to ensure the successful implementation of the actions of this Climate Adaptation Strategy, to set strategic direction, to report on progress and encourage local innovation.	**Management Team**	✓	Short
2	Integrate Climate Action into the Service Delivery Programmes and provide for its translation to Team Development Plans and Personal Development Plans to enable actions to be directly pursued per business unit/section.	**Management Team** Each Directorate	✓	Short
3	Ensure that climate action is a standing item on the Agenda of all Management Team meetings.	**Management Team** Each Directorate	✓	Short
4	Appoint a Climate Action Officer with responsibility for climate related activity within Cork County Council.	**Management Team**	✗	Short
5	Liaise with the Climate Action Regional Office and provide progress and update reports when requested. Assist the CARO in its development as a centre of excellence in the Atlantic Seaboard South Region.	**Each Directorate**	✓	Short - Medium

Objective: To ensure that climate adaptation is mainstreamed into all activities and operations of Cork County Council				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
6	Manage and oversee the effective mainstreaming of Adaptation measures into all plans, programmes, strategies and policies* of Cork County Council: (a) Build and strengthen partnerships and promote inter-departmental communications and co-operation (b) Compile a list of all plans, strategies and policies including expected review/update timelines and ensure integration of climate action into all reviews (c) Monitor that climate change considerations are integrated into service delivery programmes (d) Report to Management team on progress *Such plans, programmes, strategies and policies include (but not confined to): • Corporate Plan • County Development Plan • Local Area Plans • Biodiversity Plan • Heritage Plan • Severe Weather Plan • Winter Maintenance Plan • Roads Programme • Housing Strategy • Local Economic and Community Plan • Economic Strategy • Tourism Strategy • Safety Management Systems	**Climate Action Steering Group** Management Team	✓	Short - Medium

Objective: To develop and maintain a resource and risk model for Cork County Council				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
7	Risk assess Cork County Council activities in the context of climate change by: • Collection and collation of historic weather event data • Compilation of international and national data on projected climate patterns	**Environment** **Climate Action Steering Group**	✗	Short - Medium

8	Risk assess Cork County Council activities in the context of climate change by: • Identification of vulnerabilities of Cork County Council in the context of emerging climate knowledge	**Each Directorate**	✕	Short - Medium

9	Develop a system to document, monitor and analyse data on the impact of extreme weather events on Cork County Council which shall take into account the following baselines:
	
	• Nature and extent of extreme weather events
	• Impact of extreme weather events on public service delivery
	• Impact of extreme weather events on Local Authority assets.
	• Actions taken to adapt to events and to restore services
	• Resources required to deal with the impact of extreme weather events
	• Resource deficits identified in dealing with extreme weather events, including the H&S aspects of prolonged events on rest times
	• Financial implications of extreme weather events, including:
	  • clean up and repair costs
	  • central government funding received
	  • Opportunity costs of extreme weather events
	• Number of days of closure of Local Authority buildings
	• Staff working days lost
	• Lost activities due to reassignment or loss of resources.
	• Number of activations of Severe Weather Assessment Team
	• Number of emergency road closures
	• Number of emergency call outs
	• Number (and dates) of call outs to deal with wild fires
	• Number of Health and Safety incidents
	• Number of kilometres of road treated in freezing and high temperature conditions
	• Number of representations and calls for assistance from elected representatives, customers, other sectors and members of the public
	• The nature, extent and cost of service provided to or obtained from other sectors
	• The proportion of the impacts that is deemed to derive from climate change
		Climate Action Steering Group
		
		Each Directorate
			✕	Short

Objective: To build resilience within Cork County Council to support service delivery				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
10	Develop Business Continuity Plan to identify and address specifically, the impacts associated with extreme weather events on all functions/services of the Local Authority and explore potential opportunities to increase resilience. This will involve: • Prepare for and minimise the impact of service disruption • Assess the Local Authority's back-up system's infrastructure and review of power outage back-up procedures to ensure resilience • Develop a Contingency Plan for identified essential key staff to be able to access all essential Local Authority systems remotely due to a climate event to reduce or eliminate climate event impacts on statutory deadlines and backlog. • Assess impact of climate events on outdoor working/site visits and any impacts on deadlines and level of service provided • Assess staff working environments during extreme weather events, review potential ways to maintain safe working conditions and provision of alternative working locations • Develop plans for staff deployment and availability in the event of travel restrictions during extreme weather events	**Each Directorate**	✗	Short - Medium
11	Maintain the internal communication protocol for extreme weather events to increase staff awareness of potential risk to safety and to ensure all staff travel only in safe conditions.	**Severe Weather Assessment Team**	✓	Short
12	Assess back-up communication systems to ensure communication for emergency responders is maintained in the event of disruption to main communication system.	**Fire Services** **ICT** **Severe Weather Assessment Team**	✓	Short

Objective: To build capacity within Cork County Council to respond effectively to extreme weather events				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
13	Develop a Climate Change and Adaptation Training Programme to educate staff and elected members on the implications of climate change on Local Authority operations and build capacity within the Local Authority.	**CARO/ESTG** **Each Directorate**	✗	Short -Medium
14	Build resilience and capacity within local communities to enhance the overall response to extreme weather events.	**Economic Development, Enterprise and Tourism** **Municipal Districts**	✓	Short - Long
15	Develop resource plans for the specific demands of climate change.	**Each Directorate**	✗	Short - Long
16	Support existing extreme weather event response arrangements and investigate further deployment of early warning systems, along with reviewing and collating information on existing early warning systems.	**Severe Weather Assessment Team** **Corporate Services** OPW Met Eireann TII	✗	Short - Long

Objective: To identify and support opportunities that may arise from pursuing adaptation efforts through the functions of Cork County Council				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
17	Identify, source and leverage funding streams for Cork County Council in the active implementation of adaptation actions and measures with an emphasis on capitalising on opportunities that will contribute both environmentally and economically to the area.	**Climate Action Steering Group** Each Directorate	✕	Short - Long
18	Support, encourage and nurture new ideas seeking to capture opportunities associated with environmental and technological advances that support low climate adaptation.	**Economic Development, Enterprise and Tourism** Other External Stakeholders	✕	Short - Long

Infrastructure and Built Environment

Objective: To increase the resilience of roads and transport infrastructure				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
19	Develop an integrated system, in the context of climate vulnerabilities, for the management of transport infrastructure, including roads, bridges, walking & cycling facilities.	**Roads** **Coastal/Flood Management** **Municipal Districts/ Harbour Master** RLRDO/NRDO/ TII	✕	Medium

20	Review information available from existing asset management systems such as the Pavement Management System, Eirspan Bridge Management System and Bridge Asset Management Programme (BAMP).	**Roads** **Coastal/Flood Management** **Municipal Districts/ Harbour Master** RLRDO/NRDO/ TII	✕	Short
21	Compile a vulnerable infrastructure inventory to aid works prioritisation and inform route prioritisation plans.	**Roads** **Coastal/Flood Management** **Municipal Districts/ Harbour Master** RLRDO/NRDO/ TII	✕	Medium
22	Establish a procedure for structural integrity assessments of infrastructure after extreme weather events.	**Roads** **Coastal/Flood Management** **Municipal Districts/ Harbour Master** RLRDO/NRDO/ TII	✕	Medium
23	Integrate climate considerations into the design, planning, tendering process and construction of all transport infrastructure.	**Roads** **Coastal/Flood Management** **Municipal Districts/ Harbour Master** RLRDO/NRDO/ TII	✕	Medium

24	Develop actions plans for the adaptation of Local Authority roads and transport infrastructure to reduce the impacts of climate change.	**Roads** **Coastal/Flood Management** **Municipal Districts/ Harbour Master** RLRDO/NRDO/ TII	✕	Short - Long
25	Evaluate the requirements of roadside tree and hedgerow maintenance in the context of extreme weather events.	**Roads** Landowners	✕	Short
26	Integrate climate considerations into the design, planning and construction of all roads, footpaths, bridges, public realm, coastal and other construction projects and make provision to incorporate green infrastructure as a mechanism for carbon offset within projects as well as for wider environmental benefits such as providing shade to alleviate heat stress, supporting urban bio-diversity, water retention and flood alleviation.	**Planning Section** Roads Architectural Services	✕	Medium

Objective: To increase the resilience of Cork County Council buildings, housing stock, architectural heritage and other capital assets				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
27	Develop an integrated system, in the context of climate vulnerabilities, for the management of capital assets, including buildings, housing stock, fleet, recreation areas and public amenities.	**Each Directorate**	✕	Medium
28	Review information available from existing asset management systems such as the iHouse System and any other relevant documents.	**Each Directorate**	✕	Short
29	Compile a vulnerable infrastructure inventory to aid works prioritisation.	**Each Directorate**	✕	Medium

30	Establish a procedure for structural integrity assessments of assets after extreme weather events.	**Each Directorate**	✗	Medium
31	Integrate climate considerations into the design, planning and construction of all capital projects.	**Each Directorate**	✗	Medium
32	Undertake a gap analysis of the Local Authority fleet in the response to extreme weather events.	**Roads** Each Directorate	✗	Medium
33	Develop actions plans for the adaptation of Local Authority buildings, housing and assets to reduce the impacts of climate change on occupants.	**Each Directorate** Energy/SEAI	✗	Short - Long
34	Review the tenant's handbook to increase awareness of extreme weather events and provide climate change resilience information.	**Housing**	✗	Short
35	Ensure that climate change is considered in locating and planning future developments.	**Each Directorate**	✓	Medium

Objective: To increase the resilience of Cork County Council coastal infrastructure including harbours, piers, beaches				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
36	Develop an integrated system, in the context of climate vulnerabilities, for the management of coastal infrastructure, including, harbours, piers and beaches.	**Coastal/Flood Management** **Municipal Districts/ Harbour Master** RLRDO/NRDO/ TII	✗	Medium
37	Work with national and regional agencies to develop Coastal Zone Management Plans to identify at risk coastal erosion and deposition zones and, where appropriate, actions to manage climate risk and build resilience to climate change.	**Coastal/ Flood Management** Relevant Government Depts OPW EPA GSI Marine Institute	✗	Short/ Medium

Landuse and Development

Objective: To Integrate climate action considerations into landuse planning policy				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
38	During the Review of the Cork County Development Plan and Local Area Plans identify and integrate climate change as a critical consideration, guiding principle and strategic objective, and tailor planning policies to reduce the vulnerability of Co. Cork to the impacts of climate change, for example by: • Enhancing the role of the natural environment to promote climate adaptation through promoting green infrastructure • Continuing to take a risk-based approach to development in areas at risk of all types of flooding (coastal, fluvial, pluvial and groundwater) • Designing urban areas to incorporate shading/ cooling areas and water features to provide for urban heat reduction. • Promoting climate resilient designs and materials	**Planning** Each Directorate	✗	Short
39	Evaluate and implement best practice in Sustainable Drainage Systems (SuDS) in the context of climate change.	**Planning** **Roads**	✗	Short - Medium

Drainage and Flood Management

Objective: To adapt to the increased risk and impact of flooding				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
40	Work with the OPW and other organisations in information sharing in relation to flood risk and in the development of major and minor flood protection and flood proofing schemes throughout the county, encouraging a whole of catchment approach to the flood management and promote the requirements of our natural and cultural heritage in relation to flood relief works which may be carried out in the context of climate change	**Coastal/Flood Management** OPW	✓	Short

41	Ensure that flood event emergency response plans are reviewed on a regular basis to reflect the increase in flood risk due to climate change.	**Severe Weather Assessment Team** Roads Fire Services	✓	Short
42	Compile an inventory of existing drainage districts for which Cork County Council is responsible.	**Roads**	✓	Short
43	Develop management plans for Cork County Council drainage districts taking into account impacts from climate change such as increased siltation and plant growth.	**Roads**	✗	Medium
44	Work with Irish Water to identify combined sewers that are at risk of surcharging during extreme rainfall events and develop suitable solutions.	**Roads** **Irish Water** Water Services	✗	Medium
45	Investigate the use of smart monitoring in the management of Cork County Council drainage systems.	**Roads**	✗	Short - Medium
46	Explore opportunities to install systems similar to those currently operating in the County in areas subject to flooding with reference to CFRAMS.	**Climate Action Steering Group** Environment OPW	✗	Short -Long Term

Natural Environment, Built and Cultural Heritage

Objective: To protect and enhance the natural environment and support Bio-diversity				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
47	Support efforts to attain water quality standards set out in the Water Framework Directive.	**Environment**	✓	Short
48	Evaluate the requirements of Bio-diversity in relation to roadside tree and hedgerow maintenance in the context of climate change.	**Roads** **Planning** NPWS Landowners	✗	Short - Long
49	Identify invasive species whose spread is linked with climate change. Develop appropriate management techniques for their control.	**Planning** Climate Action Steering Group Environment NPWS	✗	Short - Long
50	Develop a plan to support an active native tree planting programme in conjunction with an awareness campaign that informs of the benefits to communities in improving air quality, offsetting carbon emissions, promoting biodiversity, limiting flood risk, reducing urban heat, as well aesthetic value.	**Planning** Roads	✗	Short-Medium
51	Support provision for natural borders/buffers and include as integral component of the design of greenway/ blueway, tracks, trails, amenity and tourism areas to promote the natural enhancement and influence positive user experience. Consult with the NPWS to ensure appropriate buffer zones are provided, maintained and protected to avoid individual impacts on designated species area habitats, and to protect and enhance wider bio-diversity	**Planning** Roads	✗	Short-Long

Objective: To protect Heritage and Cultural Infrastructure				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
52	Develop a system to document, monitor and assess the impact of climate change on Cork County Council owned heritage and cultural assets	**Planning**	✗	Short - Long

Community Health and Wellbeing

Objective: To build capacity and resilience within communities				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
53	Raise awareness of the impacts of climate change and ways for communities to increase response and resilience to these impacts. This should include: • Information on Severe Weather Event preparedness • Property security and safety • Health issues related to extreme weather events • Public safety awareness • Water safety awareness for unsupervised watercourses in local areas • Local resources to adapt to events e.g. road salting	**Environment** **Economic Development, Enterprise & Tourism** National Dialogue & Climate Action Civil Defence OPW Gardaí HSE Department of Rural and Community Development	✓	Short

54	Develop a programme to enhance capacity to respond to and recover from extreme weather events with specific aims to: • Help the vulnerable community to develop a stronger facilitating role for mitigating risks • provide advice on the risk of extreme events affecting their locality • Devise adaptation actions to enhance preparedness and reduce dependency on Local Authority emergency responses • Provide support to develop appropriate resilience arrangements to enable response and recovery	**Climate Action Steering Group** **Economic Development, Enterprise & Tourism** Civil Defence Libraries Section Gardaí HSE Fire Services	✕	Medium
55	Develop public awareness campaigns to increase knowledge of and encourage behavioural change around climate change and severe weather events.	**Climate Action Steering Group** **Environment** **Economic Development, Enterprise & Tourism** Corporate Services Libraries Section MET Eireann	✕	Short

Other Sectors and Agencies

Objective: To collaborate with other Sectors and Agencies in programs relating to climate change				
No.	**Action**	**Lead Council Department** & Partner(s)	**Budgeted**	**Timeframe S/M/L**
56	Liaise, collaborate and work in partnership with the Sectors identified in National Adaptation Framework in the delivery of the Sectoral adaptation actions, as approved by government, where they are relevant to the functions and activities of Cork County Council.	**Each Directorate** Department of Agriculture, Food and the Marine Department of Culture, Heritage and the Gaeltacht Department of Transport, Tourism and Sport Department of Communications, Climate Action and Environment Office of Public Works Department of Housing, Planning and Local Government Department of Health	✗	Short - Long
57	Work with the Government Departments to: • Identify funding streams available to communities to enable local climate action resilience and adaptation projects • Harness and enhance delivery methods for community funding for climate action	**Economic Development, Enterprise & Tourism** Tidy Towns NGO PPNs	✓	Short
58	Review and revise Emergency Management Plans and protocols to ensure that they provide for appropriate inter sectoral stakeholder engagement for Climate Change Impact response.	**Environment**	✓	Short

Chapter 06

Implementation, Monitoring & Evaluation

6.1 Introduction

This strategy has implications for the functions and operations of Cork County Council. It is therefore imperative that the Climate Adaptation Team brings together representatives from all key functional areas. Personnel with various technical, operational and management expertise will be a key component in successfully carrying out the necessary tasks and ensure that the actions outlined in the report are implemented.

Climate adaptation will continue to evolve and it is for this reason that the Climate Adaptation Team will remain following the preparation of the adaptation strategy. It is envisaged that the Adaptation Team will meet quarterly. The tasks of the team are as follows:

1. **Prioritise actions within the short, medium and long term delivery timeframes**
2. **Develop an approach and initiate implementation of the actions**
3. **Liaise with other stakeholders and sectors, both locally and regionally, where required for the implementation of actions**
4. **Monitor and evaluate implementation of the actions**
5. **Report on Progress to the relevant SPC's and full Council**
6. **Respond to changing adaptation and mitigation requirements and ensure that Council policies and procedures are updated accordingly**

The preparation of the strategy has identified the need for 'baseline' information to monitor implementation. These baselines have been set out in Action 9 and will provide systems for such parameters as the extent of impact and the financial cost of extreme weather events.

6.2 Prioritise Actions

An essential task is to prioritise adaptation actions for delivery within the short, medium and long term timelines as defined in Section 5.3 of this Strategy. Actions are to be assigned timeframes for implementation and assigned to the relevant Directorate of the Local Authority who will assume responsibility for same.

6.3 Develop an approach and initiate implementation

The purpose of this task is to break down the adaptation framework into what actions will be taken and when, and who will carry out the actions by way of an Implementation Plan. Any projects that emerge as a result of the strategy will be subject to screening for EIA and AA and EIA and AA as necessary. The Steering Group will devise a methodology for implementation that includes:

- **Who is responsible for implementing the adaptation actions**
- **Identify funding required for the adaptation measures**
- **Identify/establish key indicators or targets as mechanisms for measuring outcomes**
- **Collaboration required with other stakeholders**
- **Identification of budget implications of adaptation measures**
- **Timeframe that measures will be implemented**
- **Identify risks to the implementation of actions**

It is recommended to encompass actions into the implementation plan. Once completed, key personnel can assume responsibility and begin implementing the adaptation actions.

In implementing the actions of this strategy Cork County Council will seek to ensure that any potential environmental impacts are minimized. Actions will be examined in the context of potential co-benefits including measures such as human health, biodiversity enhancement and protection, improvement in water quality, management of areas at risk of flooding and sustainable landuse zoning and development practices. It would be important that actions yielding multiple environmental and societal benefits are prioritized.

Likewise consideration of potential adverse cumulative and in-combination environmental effects must be accounted for in selecting and implementing specific actions. Consideration of environmental sensitivities under the Habitats Directive and Water Framework Directive for example are important in the context of potential adverse cumulative or in-combination effects.

For the purpose of monitoring and reporting on progress, mal-adaptation will be identified and approaches to counter this will be explored thoroughly and put in place.

6.4 Liaise with other Stakeholders/Sectors

As mentioned throughout the Adaptation Strategy, the Local Authority will be required, as considered necessary, to liaise with other key stakeholders to provide for the delivery of actions. By the same token, the sectors, as identified in the National Adaptation Framework, will engage and liaise with Local Authorities in the delivery of sectoral adaptation actions stemming from their respective adaptation plans.

To expand on the practical delivery of actions of this strategy an implementation plan will be developed. The requirements of the SEA Directive and Habitats Directive will be critical considerations in the implementation plan as is necessary and appropriate and as they apply to individual projects in the course of their progression and development.

6.5 Monitor and Evaluate Implementation

Monitoring and evaluating the implementation of actions is critical to ensure the long-term success of climate adaptation actions. It is essential in (a) tracking the performance of activities within the lifetime of this strategy, (b) determining whether planned outcomes from adaptation actions have been achieved and (c) determining whether new adaptation actions should be undertaken, or existing ones modified.

The climate adaptation team will use results from the monitoring and evaluating program to:

- Revisit vulnerability and risk assessments conducted as part of adaptation actions
- Make changes where appropriate based on monitoring results and feedback from Local Authority staff
- Update Climate Adaptation Strategy where the need arises
- Include new climate science and recent extreme climatic hazards/events
- Factor in changes to exposure to climate risks and/or adaptive capacity and
- Evaluate the success or outcome of completed actions.

This means that adaptation actions will be informed by latest climate change data and projections. As a result, monitoring, and evaluation can help improve the efficiency and effectiveness of adaptation efforts within the Local Authority. Part of the monitoring will also involve documenting climate events themselves, which will inform future adaptation and mitigation policies.

The Atlantic Seaboard South Climate Action Regional Office (ASBS CARO) together with the other 3 CARO Offices will continue to assist and provide guidance where possible in the practical implementation of the actions of this strategy. Cork County Council will continue the positive relationship, collaborate and engage with the ASBS CARO as is necessary throughout the lifetime of this strategy. In addition, there will be continuous engagement between Cork County Council and the Southern Regional Assembly to integrate climate action considerations into landuse planning policy.

6.6 Report on Progresss

The Climate Adaptation Team will develop and agree appropriate timeframes and mechanisms to report on the progress of the implementation of the actions to Local Authority Management, relevant Strategic Policy Committees and to Council as appropriate. Reporting on progress i.e. Climate Adaptation Progress Report should be prepared as agreed, for input by the Management Team and Strategic Policy Committees and review by the Elected Members.

The progress report should provide for, inter alia:

- Progress achieved on actions to that point (including key indicators as established)
- Extent to which actions have built new relationships with key stakeholders, agencies, communities and identified new or emerging opportunities
- Identification of funding streams used
- Encouraged positive community engagement
- Reports on the outcomes of efforts to change behaviour

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