



Climate change adaptation of major infrastructure projects

Country report for Ireland

Prepared by:

Antonio De Rose (EY)
Filippos Anagnostopoulos (EY)
Anthony Tricot (EY)
Navdeep Sandhu (EY)
Ilse Laureysens (Arcadis)

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Unit F1 – Closure and Major Projects

Contact: Jonathan DENNESS, Head of Unit

Camelia-Mihaela KOVÁCS, Administrator

E-mail: REGIO-MAJOR-PROJECTS@ec.europa.eu

*European Commission
B-1049 Brussels*

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Note for the readers of the printed version: the present country report links to a large number of resources via hyperlinks, which by nature are only active in the electronic version. In order to find the identified resources, an online search will usually deliver the right result; but otherwise it is also possible to make use of Annex II of the main report where all the identified resources and their hyperlinks are presented.

Disclaimer: The identified resources are non-exhaustive and present a snapshot of the readily available and accessible material during 2017. This information was collected through finite web-based desk research, and through questionnaires and interviews aimed at the relevant national competent authorities (ESIF managing authorities, research institutes, ministry officials, etc.). Further resources might be available but not accessible due to privacy restrictions, or a lack of mandate to share related material. Following the publication of the present report, more resources will continue to reach the public domain, including through Climate-ADAPT and the identified national websites.

1. INTRODUCTION

The [EU Strategy on Adaptation to Climate Change](#) of 2013 includes actions to enhance the resilience of infrastructure and mainstream climate adaptation into the European regional and cohesion policy. The [Common Provisions Regulation](#) (CPR) of 2013 states under article 8 that climate change mitigation and adaptation, and risk prevention shall be taken into consideration for investments made with the support of the European Structural and Investment Funds (ESI Funds). The regulation integrates climate change adaptation considerations into the preparation and approval of major projects¹ or other projects funded by the ESI Funds through the requirement to conduct climate change vulnerability and risk assessments. In coordination with the ESI Funds, and complimentary to them, the LIFE fund in addition assists in the realisation of the climate change adaptation objectives. Climate change analyses (such as vulnerability and risk assessments) are also sporadically found to be undertaken for infrastructure projects that are financed outside the framework of EU funds.

This report for Ireland focuses on the adaptation to climate change of infrastructure projects supporting the requirement to undertake climate change vulnerability and risk assessments by presenting:

- **Legal, policy and institutional framework:** A schematic outline of national and regional policy and legal framework, and organisational structure to deal with adaptation;
- **Resources:** Offering the most important resources supporting the realisation of climate change vulnerability and risk assessments for infrastructure projects. The available resources for data, methodologies, tools, guidance, design standards, system framework and institutional capacity are contextualised and listed in this section;
- **Sector overview:** Identifying the approach, main strengths and weaknesses for each of these sectors: Transport, Broadband, Urban development, Energy, Water and Waste;
- **Case studies:** Current practice in adaptation and resilience of infrastructure projects.

Country Overview

The [Climate Action and Low Carbon Development Act](#) (2015) includes Ireland's National Climate Change Adaptation Framework, which provides the policy background, and determines the development of adaptation projects. The key stakeholders for climate change adaptation in Ireland are the Department of Communications for Climate Action and Environment ([DCCAE](#)), local authorities, the Environmental Protection Agency ([EPA](#)), individual sectors and [MET Eireann](#). The [DCCAE](#) role is to coordinate, identify key sectors and encourage sectors to make vulnerability and risk assessment for their own areas. [DCCAE](#) is now working on a new [Adaptation Framework \(2013\)](#) to replace the 2012 National Plan. Approval is expected in 2018, and sectors will be expected to produce their own plans and strategies for climate change adaptation.

A number of resources are available for climate adaptation. Ireland's most comprehensive web portal for information on climate change adaptation is [Climate Ireland](#). The majority of present findings are interpreted from scientific research and tailored for individual sectors. The Climate Change Research Programme ([CCRP](#)),

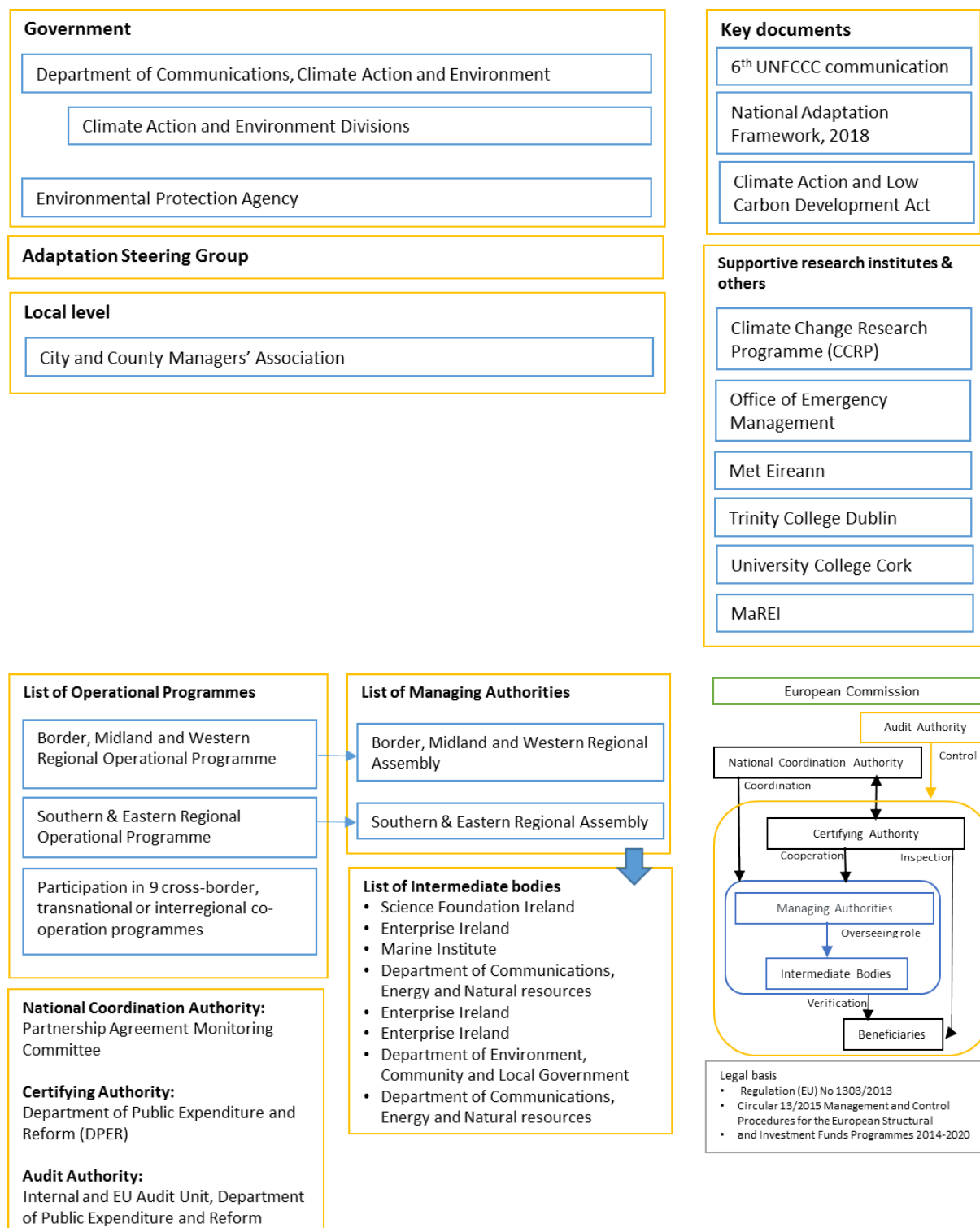
¹ major project: an operation comprising a series of works, activities or services intended in itself to accomplish an indivisible task of a precise economic or technical nature which has clearly identified goals and for which the total eligible cost exceeds EUR 50 000 000 and in the case of operations contributing to the thematic objective under point (7) of the first paragraph of Article 9 of Regulation 1303/2013 where the total eligible cost exceeds EUR 75 000 000

(established and administered by the [EPA](#)), supports research addressing specific knowledge gaps of direct relevance to the [National Climate Change Strategy](#). In terms of physical climate change-based parameters, [Met Éireann](#) (Met) contains historical data on specific parameters which assess the magnitude of climate change. [Climate Ireland](#) provides a range of tools for supporting climate adaptation assessments, such as the Local Authority Adaptation Support Wizard; EC Adaptation Support Tool; Case Study Search Tool and Business Areas Climate Assessment Tool. A [Sectoral Adaptation Support Wizard](#) also helps a guide sectors in identifying current and potential future vulnerabilities and assessing available adaptation options. With regard to national reports, the [National Climate Change Adaptation Framework](#) (2012) sets the basis for subsequent guidance. This framework is currently being reviewed with an update expected in 2018, covering both national and sectoral guidance. In developing a national climate change strategy for Ireland, an assessment of vulnerability at an early stage is essential in order to inform subsequent stages of the process. This was carried out in the [Current and Future Vulnerabilities to Climate Change in Ireland \(2013\)](#) study. Design standards follow a similar style to the guidance documentation; using the [National Adaptation Framework \(2012\)](#). Despite each sector integrating climate change adaptation consideration into their design standards, on a project case-by-case basis, there is no formal requirement. Ireland's [National Adaptive Capacity Assessment](#) looks at of Ireland's capacity to adapt to climate change. It follows the approach developed by the World Resources Institute. The [EPA](#) carried out an analysis of Ireland's institutional capacity, detailed in their [Climate Change Research Programme \(2013\)](#) report. The report outlines the main findings of the [National Adaptive Capacity Assessment \(2013\)](#) and makes recommendations on how adaptive capacity may be improved. The [Science Foundation Ireland Investigators Programme](#) supports and encourages researchers to build capacity, expertise, collaborations and relationships in areas of strategic economic importance through themed calls. A liaison officer within the [Met](#) has been employed to raise awareness on institutional capacity for climate change adaptation, with the [ERA4CS project \(2015\)](#) showing immediate signs of progress. EU resources are in use, such as the [Guide to Cost-Benefit Analysis of Investment Projects](#), the publication on [Climate Change and Major Projects](#) and the non-paper [Guidelines for Project Managers](#).

Infrastructure sectors are undertaking actions to adapt to climate change. As with other sectors, assessment of climate change adaptation issues in the transport sector relies on use of [Climate Ireland](#) and its web-portal. The study '[Developing resilience to climate change in the Irish transport sector](#)' published by [DTTAS](#), analysed the vulnerabilities of five transport subsectors (aviation, road, bus, rail and ports) to the impacts of climate change. Broadband infrastructure (particularly fixed assets) may become more vulnerable to climate change, as detailed in the [National Adaptive Capacity Assessment](#) report. For urban development, the [National Spatial Strategy](#), published in 2002, covering the period 2002 - 2020, aims to achieve a better balance of social, economic and physical urban development across Ireland. Regionally, the [UrbanAdapt](#) project seeks to identify the impact of climate change on Dublin and surrounding towns within the Greater Dublin Region. In the energy sector, the draft Adaptation Plan for Energy is being prepared in the context of the NCCAF with its objective to identify options for electricity and gas networks infrastructure and services that will help to build resilience against the impacts of climate change. Water supply within Ireland is currently "*under pressure*" and has been deemed "*inadequate*" by [Climate Ireland](#) due to a severe need of renovation. The [Flood Risk Management Climate Change Adaptation Plan \(2015\)](#) has been prepared under the remit of the National Climate Change Adaptation Framework, setting out the approach to climate change adaptation of the [Office of Public Works](#) (OPW), the lead agency for flood risk management in Ireland. In the waste sector, [the Environmental Protection Agency \(EPA\)](#) supports a variety of policies specific to the management of waste, and the country complies with the EU [Directive 1999/31/EC on the landfill of waste](#).

The case studies identified in Ireland and which are further developed in this country report, include the EPA funded [Urb-ADAPT](#) project, the [Connecting Nature](#) project, and the Met Éireann [ReAnalysis](#) Project.

2. LEGAL, POLICY AND INSTITUTIONAL FRAMEWORK



The Department of Communications, Climate Action and Environment (DCCAE) is a central component of the climate change governance architecture, leading and co-ordinating national adaptation policy and supporting the implementation of the adaptation effort at national, sectoral and local government levels.

The Climate Action and Low Carbon Development Act (2015) provides for the development of a National Climate Change Adaptation Framework (NCCAF). The 2015 Act foresaw the development of the [National Adaptation Framework \(NAF\)](#), adopted in early 2018, which sets out the national strategy to reduce the vulnerability Ireland to the

negative effects of climate change and to avail of positive. It has been prepared by the Department of the Environment, Community and Local Government, through the Adaptation Steering Group. These sectoral adaptation plans should be revised and updated at least every 5 years.

Research on climate change impacts and adaptation is co-ordinated by the Environmental Protection Agency, through its Climate Change Research Programme. The programme supports and develops research to inform decision making and planning on adaptation and identify options to reduce the adverse impacts of climate change and their associated costs.

The European Regional Development Funds are mainly absorbed through two regional programmes, each managed by the relevant Regional Assembly.

3. RESOURCES

This country report has reviewed the currently available resources in Ireland for adapting to the impacts of climate change across six key infrastructure sectors. Adaptation to climate change is integrated in the legal basis² for ESIF-funded projects, through the processes of vulnerability and risk assessments which are, broadly:

1. Vulnerability – evaluating the sensitivity and exposure of infrastructure to climate change
2. Risk – estimating the likelihood and impact of relevant climate hazards
3. Adaptation - consideration of adaptation options and integration into the project planning

The legal requirements for major projects also foresee climate change mitigation. This study however is focused on climate change adaptation and does not cover mitigation aspects.

Information on the requirements for climate change adaptation is available in the 2016 publication [Climate Change and Major Projects](#), and details on the methodology of climate resilience analysis is provided in the 2017 JASPERS publication [The Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#). Further resources are being identified in the present publication and its references. Effective vulnerability and risk assessments for the adaptation of major projects to climate change require the resources explained in the following table:

Resources	Explanation
Data Availability	The availability, accessibility and applicability of data on climate projections and impacts, on past and historic events, on geophysical parameters, on long-term scenarios, on economic, environmental and social impacts, etc.
Methodologies	The existence of quantitative or qualitative methodologies (a system of processes, a set of principles and rules) for integrating climate change adaptation in the development of infrastructure projects.
Tools	The availability of tools for planning, evaluation, impact estimation (i.e. software, maps, computer simulations, long term climate forecasts

² Regulation (EU) No 1303/2013, Commission Delegated Regulation (EU) No 480/2014, Commission Implementing Regulation (EU) No 1011/2014, No 215/2014, 2015/207; and the Directives 2001/42/EC, 2011/92/EU and 2014/52/EU

	etc.) to assist with the adaptation of infrastructure to climate impacts
Guidance	The provision of guidance on how to use methodologies (i.e. for conducting climate change vulnerability and risk assessments) or develop the required infrastructure project documentation relating to climate adaptation.
Design Standards	The availability of published engineering design standards (i.e. by BSI, DIN, ISO) for infrastructure projects that include sections or appropriate provisions to ensure resilience to climate change impacts
System	The institutional and legal framework that the formal authorities work with to deliver their primary responsibilities for climate adaptation, infrastructure, and management of European Structural and Investment Funds
Institutional Capacity	The human and technical capacity of institutions to carry out their functions. It depends on being adequately resourced, on having the appropriate expertise, and on collaborating effectively and enforcing laws and regulations

3.1. Data Availability

Quantitative data are essential to understand the relevant risks and the requirements for any corresponding climate change adaptation in key sectors. Ireland's most comprehensive web portal for information on climate change adaptation is [Climate Ireland](#). This is an EPA-led project which is now coming to an end, although the Department of Communications, Climate Action and Environment ([DCCAE](#)) will be maintaining the website thereafter. The majority of present findings interpreted from scientific research/studies, and tailored for individual sectors. An existing challenge is that the portal does not contain enough of the sector-specific detail that bodies such as the Department of Transport, Tourism and Sport ([DTTAS](#)) require to have a greater understanding of climate change adaptation.

The Climate Change Research Programme ([CCRP](#)), (established and administered by the [EPA](#)), supports research addressing specific knowledge gaps of direct relevance to the [National Climate Change Strategy](#). The CCRP outputs are aimed at strengthening data and the information base by filling knowledge gaps; a significant number of research projects have been funded to date with a focus on policies and measures needed to adapt to the impacts of climate change. Research institutes active in the area of climate adaptation, include [NUIM](#), [University College Cork](#), [Trinity College Dublin](#), and [MaREI](#). Some of the aforementioned institutions are also part of the International research network CIRCLE ([Climate Impact Research Coordination for a Larger Europe](#)). Regarding the research on climate adaptation, the IGEEES published the 2017 [Climate Change Related Research & Funding in Ireland](#). The [Royal Irish Academy](#) is also engaged with climate change.

In terms of physical climate change-based parameters, [Met Eireann](#) contains historical data on specific parameters which assess the magnitude of climate change e.g. hourly, daily and monthly records of rainfall, precipitation, number of rain / wet days per county. The Met maintains a network of weather / rainfall stations that regularly provides live data on climate-based parameters, allowing the Met to produce long-term averages and maintain a focus towards extreme value analysis e.g. annual temperature changes. Approximately 90% of data is open-source available for use and re-use. The Irish [Central Statistics Office](#) maintains a national database, links with international databases, and offers access to other public sector databases. The exact content of these databases was not examined in the context of the present study. Ireland also maintains a [web portal for](#)

[flood maps](#), providing tools to search for and display information about selected historical flood events.

Projections of climate change in Ireland for 2050 and 2100 utilise outputs from Global Climate Models (GCMs). These are downscaled using both dynamic and statistical approaches. New global model simulations carried out in Ireland by Met Éireann (2013) provide an update on the expected changes in the Earth's climate over the 21st Century.

[Ireland's Sixth National Communication](#) to the United Nations Framework Convention on Climate Change (UNFCCC) also provides long-term climate change assessments across a range of sectors, with scenarios on risk and vulnerability assessments by sector.

The Office of Public Works ([OPW](#)) maintains the Catchment Flood Risk Assessment and Management ([CFRAM](#)) database of flood mapping and demonstrates vulnerable zones in respect to risk assessments and how they prioritise projects from this. [Met Éireann](#) also provides access to all meteorological-based data e.g. rainfall which aids flood and severe warning planning, whilst using OPW catchment data to assist their own data provision.

The [HydroDetect \(2013\)](#) research programme established a reference network for monitoring and detecting climate-driven trends in Irish river flow records. It facilitated more strategic monitoring of climate-driven variability and change in hydrological indicators, and enabled more confident attribution of detected trends. A report on the status of the [Irish Ocean Climate and Ecosystems \(2009\)](#) collated and analysed available marine data sets for Irish waters and put this data in a climate context. The report describes key regulators of ocean climate around Ireland and examines relevant environmental datasets available.

[Ireland in a Warmer World: Scientific Predictions of the Irish Climate in the Twenty-First Century \(2008\)](#) describes Ireland's changing climate, based on a comprehensive series of computer simulations. The objective of the project was to build a capability for carrying out regional climate modelling in Ireland and to use this resource to deliver information on the impacts of future climate change at regional level for planners and developers. Key results included that:

- The climate will continue to warm, particularly in the summer and autumn seasons: possible increases of 3 to 4°C towards the end of the century. The greatest warming will occur in the south and east of the country; and
- Autumn and winter seasons will become wetter: increases in the range 15-25% towards the end of the century. Summers will become drier: 10-18% decrease towards the end of the century.

A report on '[Key Meteorological Indicators of Climate Change in Ireland](#)' (2007) outlined the spatial and temporal variation in the observational surface climate record, including temperature, precipitation and extreme events, based on daily synoptic station data from the Met Éireann database. The results showed that across Ireland, the West, Southwest and North are wetter, with more frequent rainfall and also more intense rainfall.

The present section offers the most readily available data sources that are of use for project promoters and other interested parties. Additional information on climate adaptation is available, but not always easily accessible.

Updates for a wide range of national adaptation actions, can be found in the [National adaptation actions deliveries database on EIONET](#), and on the [Climate-ADAPT](#) website.

3.2. Methodologies

Methodologies for integrating climate change adaptation into the development of infrastructure projects rely on the basic rules of risk assessment.

The Environmental Protection Agency has published a methodological note on "[Integrating Climate Change into Strategic Environmental Assessment in Ireland](#)" (2015), which provides guidance on how to incorporate climate change (both mitigation and adaptation) into policies, plans and programmes and strategies. The document provides information on how mitigation and adaptation measures can be incorporated into a strategic environmental assessments (SEA) effectively, with guidance covering a range of sectors. The document was informed by a literature review of existing good international practices, external review, and reconfiguration of existing guidance on climate change adaptation.

3.3. Tools

Tools are highly valuable for facilitating climate adaptation studies and planning for infrastructure. They can be public or private, numerical or descriptive, and be provided in many mediums, such as software, text documents, maps, and so on. Some tools are generic (such as in risk assessments) whilst others are specific to a certain set of circumstances.

A number of tools are available for different aspects during the design phase of major infrastructure projects. [Climate Ireland](#) provides a range of tools for supporting climate adaptation assessments, such as the Local Authority Adaptation Support Wizard; EC Adaptation Support Tool; Case Study Search Tool and Business Areas Climate Assessment Tool. The [Sectoral Adaptation Support Wizard](#) tool, is structured around six steps involved in the adaptation planning cycle: 1) Preparing the Ground; 2) Climate Impact Screening; 3) Prioritisation; 4) Priority Impact Assessment; 5) Develop your Plan; 6) Implement, Monitor and Review. In addition to this, [Climate Ireland](#) has also made available a [Sectoral Adaptation Knowledge Hub](#), which details some of the challenges and opportunities that important sectors of the Irish economy are likely to face. This information should help as a guide in identifying current and potential future vulnerabilities, assessing available adaptation options and developing adaptation plans.

Whilst these tools cover various aspects of climate change adaptation from both a regional and national perspective, each [Environmental Impact Assessment](#) (EIA) will still dictate individual climate change adaptation requirements.

Tools focusing on vulnerability assessments do exist. The [EPA](#), informed by the World Resources Institute (WRI) adaptive planning cycle model, published Ireland's [National Adaptive Capacity Assessment](#) in March 2012. A key finding of the assessment is that enough information exists to start climate change adaptation planning and to implement priority actions. The report also recommends the importance of building on existing tools such as EIA and Strategic Environmental Assessments (SEA). The assessment represents a critical step in progressing the climate adaptation agenda.

With regard to decision-making, the [EPA](#) funded the Coastal Climate Adaptation and Development Project ([CLAD](#)), built capacities and developed tools to support local communities and Irish coastal authorities in decision-making on climate adaptation, through an online resource connecting end-users to the scientific, technical and policy information necessary to develop adaptive responses, and provide guidelines for effective knowledge acquisition and integration.

EIONET provides [Flood Maps](#) which are publically available, mapping areas of potential significant flood risk. EIONET also contains Flood Risk Management Plans.

For a continual update of available tools, the reader is referred to the European Climate Adaptation Platform [Climate-ADAPT](#), which has a dedicated tools section.

3.4. Guidance

Guidance is an essential requirement to ensure consistency in applying methodologies and tools. The [OPW](#) guidance documentation is in place to incorporate climate change adaptation impacts e.g. rising sea level, with EU-wide standards often used in engineering-based projects. With regard to national reports, the [National Climate Change Adaptation Framework](#) (2012) sets the basis for subsequent guidance. This framework is currently being reviewed with an update expected in December 2017, covering both national and sectoral guidance.

In developing a national climate change strategy for Ireland, an assessment of vulnerability at an early stage is essential in order to inform subsequent stages of the process. This was carried out in the [Current and Future Vulnerabilities to Climate Change in Ireland \(2013\)](#) study. The aim of this assessment was to identify first generation vulnerabilities for Ireland based on a sensitivity analysis across the key sectors. The results characterise the most vulnerable sectors ahead of a fuller climate change risk assessment which can inform subsequent adaptation options. There are also a selection of local authority development plans anticipated.

The publication '[A Summary of the State of Knowledge on Climate Change impacts for Ireland](#)' (2009), summarises the current state of knowledge on climate change and expected impacts for Ireland. It will be of use to policy-makers and stakeholders interested in or working on adaptation to climate change. The report provides information on observed and projected changes in the atmospheric, terrestrial, hydrological and ocean domains. Headline impacts are outlined for a number of sectors with indicative uncertainty levels.

3.5. Design Standards

Design standards are critically important for all infrastructure projects to ensure stability and optimal functioning under the strain of natural phenomena. For civil works (including bridges, buildings, masts and towers for the mobile access networks), EN standards are available to address natural forces such as wind and snowfall, e.g. EN1991-1-4 (Eurocode 1) and EN1993 (Eurocode 3) for structures in steel. However, these standards might be outdated and not account for the impacts of climate change.

The [National Standards Authority of Ireland](#) is collaborating with the [European Standardization Organizations](#) in the context of the EU Regulation No 1025/2012 on European standardisation. The European Committee for Standardisation (CEN) and Electrotechnical Standardisation (CENELEC) established the [Adaptation to Climate Change Coordination Group \(ACC-CG\)](#) to coordinate standardisation work in the field of adaptation to climate change in support of the implementation of the EU Strategy on Adaptation to Climate Change. More information is available in the main report at the section on Available resources at the EU level).

Design standards follow a similar style to the guidance documentation; using the [National Adaptation Framework \(2012\)](#). Despite each sector integrating climate change adaptation consideration into their design standards, on a project case-by-case basis, there is no formal requirement at national level.

3.6. System

The institutional system for adapting to climate change requires a legal framework (laws and implementing regulations) and strategies and policies (with implementing action plans). The system is usually conflated with disaster management (and its various components, preparedness, reduction etc.) and more generally with resilience.

Institutional and legal framework

Ireland introduced the national [Climate Action and Low Carbon Development Act \(2015\)](#) which details a framework for climate adaptation. The [Climate Act \(2015\)](#) provides a strong policy background, and strengthens how climate change adaptation projects are developed. Environmental impact legislation was also amended in 2014 to include climate change adaptation and plays a much more prominent role now.

Prior to the [2015 Climate Act](#), there was no climate change adaptation legislation in Ireland, although the [National Climate Change Adaptation Framework \(2012\)](#) was referred to as a non-statutory guideline. This set out what was believed to be the key issues and sectors for addressing climate change adaptation in Ireland. The [DCCAE](#) role was to coordinate, identify key sectors and encourage sectors to make vulnerability and risk assessment for their own areas. Twelve sectors were identified in the NCCAF: Water, Emergency Planning, Marine, Agriculture, Forestry, Biodiversity, Heritage, Transport, Energy, Communications, Flood Defense and Health. Under the 2012 Framework and with the input and oversight of the National Adaptation Steering Committee, four draft sectoral plans covering five sectors have been developed:

1. Sectoral Adaptation Plan for Flood Risk Management (OPW, 2015).
2. Adaptation Planning - Developing Resilience to Climate Change in the Irish Agriculture and Forest Sector (DAFM, 2017) 24.
3. Adaptation Planning - Developing Resilience to Climate Change in the Irish Transport Sector (DTTAS, 2017)
4. Adaptation Plan for the Electricity and Gas Networks Sector (DCCAE, 2017).

Responsible authorities

In 2015, the [Climate Action and Low Carbon Development Act](#) was brought in to provide a legal framework for how to implement adaptation and mitigation measures. Under the Climate Action and Low Carbon Development Act, [DCCAE](#) has developed Ireland's first statutory [National Adaptation Framework \(NAF\)](#) (2018), which sets out the national strategy to reduce the vulnerability of the country to the negative effects of climate change and to avail of positive impacts.

Under the NAF a number of Government Departments will be required to prepare sectoral adaptation plans in relation to a priority area that they are responsible for. Work on these plans begun in 2018. Local authorities are required to prepare local adaptation strategies. The NAF will be reviewed at least once every five years. The NAF also aims to improve the enabling environment for adaptation through ongoing engagement with civil society, the private sector and the research community.

[DCCAE](#), local authorities, the [EPA](#), individual sectors and [MET Eireann](#) are the key stakeholders for climate change adaptation in Ireland. The National Framework requires that localities incorporate climate change adaptation strategies into future reviews of their development plans. Local authorities will be mandated under the NAF to prepare local adaptation strategies. The Minister for Communications, Energy and Natural Resources launched the Local Authority Climate Change Adaptation Strategy Guidelines in May 2016, which were designed to assist local authorities to develop their own adaptation strategies.

Local authorities are first responders to disaster-related incidents, and are coordinated at a national level by the National Emergency and Fire Department (e.g. flooding issues). The Office of Emergency Management links emergency management across government departments. [MET Eireann](#) work across sectors together with the [DCCAE](#) steering group on climate change adaptation.

Management of the ESI Funds

Funding for climate change adaptation of infrastructure, but also for the realisation of more soft measures are provided by the ESI Funds, which are under the management of the Managing Authorities (Assemblies), who oversee the Operational Programmes carrying the corresponding names:

- Border, Midland and Western Regional Assembly
- Southern & Eastern Regional Assembly

The allocated funds are reaching their final beneficiaries through the following Intermediary bodies:

- Science Foundation Ireland
- Enterprise Ireland
- Marine Institute
- Department of Communications, Energy and Natural resources
- Enterprise Ireland
- Enterprise Ireland
- Department of Environment, Community and Local Government
- Department of Communications, Energy and Natural resources

Ireland is also participating in 9 cross-border, transnational or interregional co-operation programmes

3.7. Institutional Capacity

The institutional challenge for climate change adaptation is that climate policy is a cross-cutting issue, and requires co-operation across a large number of institutions. To be effective in delivering climate change adaptation a minimum level of capacity is needed on leadership, technical and human resources, analytical capabilities, and financial support.

Ireland's [National Adaptive Capacity Assessment](#) looks at of Ireland's capacity to adapt to climate change. It follows the approach developed by the World Resources Institute. The results of the NAC assessment indicate that Ireland is in the early stages of the adaptation process. There are good-quality information and established processes and tools to plan for the positive and negative impacts of climate change. There is a need to strengthen and maintain efforts in data gathering, climate observations and analysis to inform adaptation planning.

Technical and human resources

The Climate Change Research Programme ([CCRP](#)), (established and administered by the [EPA](#)), supports research addressing specific knowledge gaps of direct relevance to the [National Climate Change Strategy](#). The [EPA](#) carried out an analysis of Ireland's institutional capacity, detailed in their [Climate Change Research Programme \(2013\)](#) report. The report outlines the main findings of the [National Adaptive Capacity Assessment \(2013\)](#) and makes recommendations on how adaptive capacity may be improved.

Training is provided to the staff of the bus services according to the guidance included in the document [Providing Transport Services Resilient to Extreme Weather](#) (prepared by Transport of London).

Effective collaboration

The [Science Foundation Ireland Investigators Programme](#) supports and encourages researchers to build capacity, expertise, collaborations and relationships in areas of strategic economic importance through themed calls. The programme supports the development of world class research capability and human capital in areas of science, engineering and mathematics that demonstrably support and underpin enterprise competitiveness and societal development in Ireland.

A liaison officer within the [Met](#) has been employed to raise awareness on institutional capacity for climate change adaptation, with the [ERA4CS project \(2015\)](#) showing immediate signs of progress. As the [Met](#) is within the Civil Service in Ireland, and is therefore prohibited from certain national schemes, applying for grants has proven a significant barrier. However, attempts to bolster capacity internally through university grants / research programmes are future high-level priorities.

Financial resources

The aim of the [Border Midland & Western Regional Operational Programme 2014 – 2020](#) is to co-ordinate, promote or support strategic planning and sustainable development and promote effectiveness in local government and public services. The programme has a funding package of €320 million from the European Regional Development Fund (ERDF).

The [ESI Funds are enabling the development of major projects](#) in the 2014 – 2020 programming period for Irelands. Concerning major projects, by early 2018, there have been additionally 4.1 Million EUR for Information and Communication technologies. The [dataset will be updated regularly](#) to reflect changes in the programme lists and major project notifications.

According to the [ESIF-viewer](#), Irelands is planning investments of 1.22 Billion EUR. Projects under the Thematic Objective 5 on promoting climate change adaptation, risk prevention and management will be receiving 16 Million EUR, with an additional 6 Million EUR approved for Network Infrastructures in Transport and Energy (Thematic Objective 7); 27 Million EUR in Environment Protection & Resource Efficiency (Thematic Objective 6); and 75 Million EUR for Information and Communication Technologies (Thematic Objective 2). The shares within these Thematic Objectives that may relate to climate adaptation are unknown.

4. SECTOR OVERVIEW

4.1. Introduction

Since 2014 the requirements for major projects to obtain ESIF funding³ demand that project applications integrate climate change considerations⁴, such as a vulnerability and risk analysis and adaptation option appraisal. At EU-level, material is available to assist in fulfilling these requirements. Key websites and documents are:

³ http://ec.europa.eu/regional_policy/archive/projects/major_projects/index_en.cfm

⁴ For a compilation of the climate change requirements for major projects in 2014-2020, see: <http://www.jaspersnetwork.org/plugins/servlet/documentRepository/displayDocumentDetails?documentId=401>

- The [Climate-ADAPT](#) website containing many links to data and a [map viewer](#)
- EUROPEAN COMMISSION Directorate-General for Regional and Urban policy: The [Guide to Cost-benefit analysis of Investment projects](#) (also referred to as the 'CBA guide')
- EUROPEAN COMMISSION DIRECTORATE-GENERAL CLIMATE ACTION: [Non-paper of Guidelines for Project Managers: Making vulnerable investments climate resilient](#)
- JASPERS Guidance note: [The Basics of Climate Change Adaptation, Vulnerability and Risk Assessment](#)
- JASPERS Guidance note: [An overview of the most important sources for integrating climate change in \(major\) projects](#)

Additional relevant material can be found in the Final Report of the present study (European Commission, 2018) in the section *Available resources at the EU level* and in *Annex I*.⁵

4.2. Transport

Investments in the transport sector are very diverse, covering roads (including bridges and tunnels), inland waterways, rail, ports/ airports, and public transport infrastructure. Any disruption caused in this sector can affect many other sectors (economic and societal) directly. Potential threats are sea-level rise and extreme weather events, such as extended heat waves, flooding, heavy rainfall or storm, and landslides amongst others. Extreme weather events are a potential threat to both infrastructure and operation of the transport system.

As with other sectors, assessment of climate change adaptation issues in the Transport sector relies on use of [Climate Ireland](#) and its web-portal. [DTTAS](#) does not have a central repository, although it is hoped in the future that this will change.

Climate change impacts will vary between transport modes and their associated infrastructure, and will also vary widely between regions. The study '[Developing resilience to climate change in the Irish transport sector](#)' published by [DTTAS](#), analysed the vulnerabilities of five transport subsectors (aviation, road, bus, rail and ports) to the impacts of climate change. It also reports on current and possible adaptation measures for the transport sector, as summarised in the following sections.

Road infrastructure

TTI has developed a number of strategies and services, such as the [Strategy for Adapting to Climate Change on Ireland's Light Rail and National Network](#), a detailed flood mapping service of the entire national road network that identifies vulnerable sections requiring more detailed assessment, a comprehensive flood protocol for addressing flooding on the road network, etc. In addition, the design standards (DMRB) have been amended to include climate change adaptation: rainfall intensities are increased by 20% to allow for climate change in the design of drainage systems and more sustainable solutions to road run-off such as the use of constructed wetlands and grassed channels are taken into account.

⁵ European Commission (2018) Climate change adaptation of major infrastructure projects. A stock-taking of available resources to assist the development of climate resilient infrastructure. Final report.

For bus services, Bus Éireann is guided by key document [Providing Transport Services Resilient to Extreme Weather](#) (prepared by Transport of London). Relevant measures include: route review and alternative planning, severe weather management plans to provide coordinated response including arrangements for staff training and storage of supplies and equipment for use during major weather events, etc.

Local authorities also play a critical role as first responders to the impacts of disruptive weather events, and they all are developing their own Climate Change Sectoral Adaptation Plan. The sector is also actively involved in the Government's National Steering Group on Emergency Planning.

Further details are available in the DTTAS ['Developing resilience to climate change in the Irish transport sector' study](#).

Railway infrastructure

The heavy rail network is operated by national railway company Iarnród Éireann and the light rail system is operated by Transdev Dublin Light Rail Ltd. under contract to TII and the National Transport Authority (NTA).

For heavy rail, Iarnród Éireann has a series of protocols, i.e. Iarnród Éireann Weather Management Protocol, aimed at assisting local managers in planning a response to a period of severe, possibly service-affecting weather. It includes response to conditions of flooding, snowfall, ice, high winds and heat. Furthermore, a set of Technical Standards and Bulletins is available to address other engineering aspects related to climatic conditions, such as:

- Flood and Scour Management Standard
- Prevention of Track Buckling
- Guidance on Alerts and Service Restrictions during Severe Weather Alerts
- Work Limitations during Warm Weather
- Six Day Weather Forecast Meteograms from Met Éireann
- Tamping and Welding in Cold Weather Conditions.

For light rail, TII has developed the [Strategy for Adapting to Climate Change on Ireland's Light Rail and National Network](#) and a Severe Weather Management Plan. In addition, new infrastructure projects are planned and designed according to [The Planning System and Flood Risk Management Guidelines for Planning Authorities](#). Especially the feasibility of projects and route options will be evaluated with reference to the Office of Public Works National Flood Hazard Mapping (www.floodmaps.ie) and with Flood Risk Assessment and Management Studies that are available.

Airport infrastructure

Ireland's largest airports are managed by two commercial semi-state companies: Dublin Airport Authority and Shannon Airport Authority.

Dublin Airport Authority subjects all plans to rigorous flood risk assessment by the local authority planning department. It also uses standard drainage models for predicted peak flows, surcharges and average flows in the drainage network. These models include a climate change factor in all calculations.

Dublin Airport Authority and Shannon Airport Authority make use of detailed weather forecasting services provided by Met Éireann and the UK Met Office. Shannon Airport is the location for a weather forecasting station that specialises in aviation forecasting.

Both Airport Authorities prepare plans to deal with various emergency response scenarios, such as terminal building evacuation, snow and ice plan, aircraft emergency and crash procedures.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

4.3. Broadband

The International Telecommunication Union has issued the recommendation L.1502 "[Adapting information and communication technology infrastructure to the effects of climate change](#)" for the purpose of identifying climate threats and their impact. L.1502 supports Resilience by design in identified risky areas, and proposes changes to equipment installation standards to ensure protection from more frequent extreme weather phenomena and their impacts. The European broadband sector standardisation bodies have not prepared vulnerability assessment and risk management framework for dealing with climate change in broadband projects.

Existing broadband infrastructure (particularly large fixed assets managed by the telecommunications sector), may become ever more vulnerable to climate change, as detailed in [National Adaptive Capacity Assessment](#) report. Extreme events present a significant risk (storm damage to overhead cables, subsidence of masts, poles, etc.); steady incremental changes in temperature, precipitation and sea levels will also present an increasing challenge to the operations and distribution of services (e.g. the impact of higher indoor temperatures on the operation of high-tech equipment or increase the risk of subsidence damage to communications masts).

With regard to EU funding of Ireland's broadband infrastructure, there is comprehensive guidance provided in [European Funding for Broadband 2014 – 2020](#). This report states that European Structural and Investment Funds are the largest EU public funding source that supports broadband investment. The report also states that the 2014 - 2020 total budget for broadband deployment in Ireland is approximately €75 Million.

It is a general best practice for operators to use flood mapping information from environmental agencies to safeguard new planned data centres from flooding. For civil works (incl. masts and towers for the mobile access networks), EN standards are available to address wind and snowfall (see section 3.1 for more details).

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

4.4. Urban Development

Investments in the urban development sector include site developments (industrial and other), urban planning, local infrastructure, building projects (such as hospitals, schools), and much more diverse projects. Cities have a unique position to analyse and respond to local impacts and vulnerabilities, such as heat island effects, which depend on the specific layout of a city, its green spaces, and numerous other factors. Cities can actively support the uptake of climate change adaptation in infrastructure projects through, for instance pilot projects, and can initiate dedicated infrastructure projects to improve their resilience to climate change.

The [National Spatial Strategy](#), published in 2002, covering the period 2002 - 2020, aims to achieve a better balance of social, economic and physical urban development across Ireland. The Strategy provides a framework for planning at national, regional and local level. Balanced regional development requires that the full potential of each region be developed on a sustainable economic, social and environmental basis to contribute to the overall performance of the country

The [EPA](#) report entitled [Co-ordination, Communication and Adaptation for Climate Change in Ireland](#) analysed the adaptation needs of Ireland. The report recommended that local authorities build adaptive capacity by establishing structures such as a high level climate change team, responsible for developing and overseeing the implementation of a climate change strategy. The report advocated for this to be integrated into their current Development Plan, whilst Regional authorities should oversee the integration of these local climate change strategies at a regional level.

The [UrbanAdapt](#) project seeks to identify the impact of climate change on Dublin and surrounding towns within the Greater Dublin Region. The project aims to identify possible risks to the population living in the Greater Dublin Region and future risks posed under a changing climate for future populations. Employing a Climate Vulnerability Indicator-based approach (CVI), spatial and temporal variations were witnessed and defined by key urban climate vulnerabilities (coastal inundation, temperature-related health impacts and flash flooding). This information will provide stakeholders with the pre-requisite information to understand current and potential future vulnerabilities and on this basis assess the direct and indirect effects (social, environmental and economic) of key urban climate impacts and vulnerabilities.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

4.5. Energy

Project investments in the energy sector are related to power generation infrastructure, energy distribution networks and energy storage (e.g. through hydropower). Potential impacts of climate change on energy infrastructure may include increased damage to power generation plants or problems with energy provision, leading to black-outs or other disruptions. Disruptions in the energy sector can have large impacts on different sectors due to the increasing dependency on (electric) power provision for all kind of operational systems such as water supply (pumping installations, ...) , the food system (transport, cooling, ...), transport, (electrified vehicles, dynamic traffic information, ...).

The draft Adaptation Plan for Energy is being prepared in the context of the [NCCAF](#) with its objective to identify options for electricity and gas networks infrastructure and services that will help to build resilience against the impacts of climate change. The plan focusses on assessing Ireland's vulnerability to key climate variables and the likely impacts of such on the electricity and gas networks, based on the current understanding of climate change and its consequences for Ireland.

The [Public Consultation on Draft Climate Change Adaptation Plan for the Electricity and Gas Networks Sector](#) aims to set out a high level policy for energy infrastructure in relation to climate change adaptation. The objective is to identify options that will help to build resilience against the impacts of climate change.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

4.6. Water

Investments in the water sector are linked to efficient water supply (including reduction of leakage), wastewater treatment and water reuse as well as the implementation of [River Basin Management Plans \(RBMP\)](#) to ensure integrated water management at the river basin scale. Important threats are linked to water quantity (droughts and floods) as well as quality (water pollution). Climate change can have an impact on both water

quantity and quality. Following the EU Floods Directive 2007/60/EC, Member States are obligated to perform flood risk assessment and to elaborate flood hazard and risk maps and [flood risk management plans](#). [Flood risk maps](#) include the history of floods and climate scenarios. Member States also need to take climate change into consideration when developing RBMP. A [Guidance document on adaptation to climate change in water management](#) is available to ensure that the RBMP are climate-proofed. [Evaluations of the RBMP and FRMP](#) are also available on the EC website.

Water supply within Ireland is currently “*under pressure*” and has been deemed “*inadequate*” by [Climate Ireland](#) due to a severe need of renovation. As a result, climate-induced impacts on demand and pressures on water resources will need to be “*effectively and sustainably managed in the context of existing and future pressures*”. Climate change will serve to exacerbate existing risks for water management and the projected areas of concern relate primarily to water supply, quality and flood risk. Climate projections indicate that water resources will become “*depleted*” both in terms of water supply and quality, and this is against a background of increasing demand due to, amongst others, increased irrigation requirements. In addition, the frequency and size of flooding is expected to increase with new areas not already subject to flooding being affected.

The aim of the [Coastal Climate Adaptation and Development \(CLAD\) \(2013\)](#) project was to assess the contextually specific demands of coastal adaptation in Ireland, and provide the tools and resources that local authorities and coastal communities might use when initiating coastal adaptation at the local scale. The circumstances under which coastal climate adaptation in Ireland should proceed were explored and the potential for enhancing the capacity of coastal communities to develop resilient responses to changing climatic conditions was examined.

Studies to date in Ireland have identified some strong climate impacts on the water sector, including an increase in river flows during winter and spring, along with reductions in late summer and autumn. The study on the Irish water sector [Adaptation to Climate Change in the Water Sector \(2013\)](#), looks at water supply management, as the characteristics of the water supply system will have a strong bearing on vulnerability to climate change. The report developed a framework for supporting adaptation to climate change and a tool for assessing adaptation options. The framework is built on the identification of vulnerability for individual surface water abstraction points, and the tool is intended as an exploratory tool to identify where and when adaptation will be necessary and to identify if certain strategies are likely to be successful under the range of likely future conditions.

The [Flood Risk Management Climate Change Adaptation Plan \(2015\)](#) has been prepared under the remit of the National Climate Change Adaptation Framework. It sets out the approach to climate change adaptation of the [Office of Public Works](#) (OPW), the lead agency for flood risk management in Ireland, based on a current understanding of the potential consequences of climate change for flooding and flood risk in Ireland, and the adaptation actions to be implemented by the OPW and other responsible Departments and agencies in the flood risk management sector. The Irish Government's medium term capital investment plan “Building on Recovery: Infrastructure and Capital Investment 2016 – 2021” includes a total allocation of €430m for flood risk management.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

4.7. Waste

Project investments in the waste sector are related to separate collection infrastructure, re-use and recycling infrastructure, energy recovery facilities and closure of landfills.

Potential impacts of climate change on waste infrastructure may include increased rates of waste decomposition, odour and dust due to increased temperatures, flooding of landfills and waste treatment facilities, and reduced water availability for wet processes in waste treatment facilities. Also the impact on transport infrastructure should be considered, as transport is a critical component of waste management (collection, transport to and from waste treatment facilities). The impact on transportation is discussed in the section on transport above. In Ireland, no specific examples, guides, tools or other instruments have been identified for the waste sector that could assist in addressing climate adaptation.

[The Environmental Protection Agency \(EPA\)](#) in Ireland supports a variety of policies specific to the management of waste. [The Waste Management Policy](#) (2012) was published by the Department of Environment, Community and Local Government, providing analysis and the identification of a number of problematic areas, without offering sufficient reference to climate change adaptation.

For landfills, [Directive 1999/31/EC on the landfill of waste](#) requires that landfills are situated and designed in such a way that safeguard against pollution of the soil, groundwater or surface water. This requirement should be translated into [national design standards](#) for the construction of landfills that include the consideration of temperature, precipitation extremes and flooding where relevant.

Large waste treatment plant are subject to [Directive 2010/75/EU on industrial emissions](#) (IED), which requires as a general principle that necessary measures should be taken to prevent accidents which may have environmental consequences, and to limit those consequences. This requires that a structured management plan should be available that includes and mitigates hazards such as extreme weather conditions (e.g. flooding, very high winds). In the [BAT reference document \(BREF\) on Waste Treatments Industries](#), some information is provided on the impact of certain climatic conditions (e.g. the impact of higher temperature on biofilter performance, aerobic decomposition, etc.). Although climate change is not specifically addressed.

See section 4.1 for more information on other documents that can help in taking climate considerations into account.

5. CASE STUDIES

5.1. Case studies of climate adaptation projects

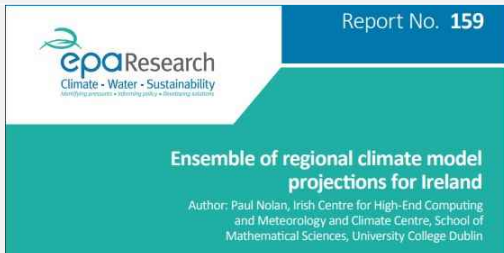
Urb-ADAPT	
Project description	The EPA funded Urb-ADAPT project (2016-2018) seeks to identify the impact of climate change on Dublin city and surrounding towns across the Eastern and Midlands Region. It involves carrying out climate modelling of temperature, coastal inundation and flash flooding for the relevant regions for the period out to 2060. The project is coordinated by the Marine and Renewable Energy Institute (MaREI), Environmental Research Institute, University College Cork and conducted in partnership with the Eastern and Midlands Regional Assembly (EMRA). Data from the project will be made available through Ireland's Climate Information Platform (ICIP), facilitated by Climate Ireland, in addition to a dedicated project website.
Photograph	N/A

Budget	N/A
Climate Change Vulnerability and Risks	The project aims to identify possible risks to the population living in the Greater Dublin Region and future risks posed under a changing climate for future populations.
Climate change adaptation measures	In the context of transport, the findings of this research will be of greatest benefit in the development of adaptation measures concerning identifying flood risk, the risk to transport infrastructure in close proximity to coastlines and the impact of changing temperatures on population health and behaviour. Projected increase in rainfall intensity in Ireland and rise in sea level will undoubtedly pose dangers to critical transport infrastructure in the future.
Good practice	The study will support decision-makers within the transport sector by providing enhanced accuracy in discerning likely areas of vulnerability to pluvial events and coastal flooding, and to outline their response capacity accordingly
Further information	www.urbadapt.com

Connecting Nature

Project description	The Connecting Nature project is an international collaboration, represented in Ireland by Trinity College Dublin. The project proposes nature-based solutions for adaptation in urban areas.
Photograph	N/A
Budget	12 Million
Climate Change Vulnerability and Risks	Ireland has become increasingly urbanised, with almost two-thirds of the population now living in cities, towns and suburbs according to the Census conducted in April 2016. As transport is a derived demand, transport services and infrastructure are highly concentrated in urban areas.
Climate change adaptation measures	A focus of study in the project is the creation of 'living' buildings, including urban transport hubs such as train stations and bus depots, by incorporating plant life into building design, which increases the rate of evapo-transpiration. This would serve to regulate temperature, providing a cooling effect on warm days and also a layer of insulation from cold temperatures in winter.
Good practice	Using nature to make buildings climate resilient is an innovative approach, which can be replicated in most other buildings.
Further information	https://connectingnature.eu/

Met Éireann ReAnalysis Project

Project description	The Irish Centre for High-End Computing (ICHEC) has conducted a climate prediction project, culminating in a definitive collection of regional modelling projections for Ireland laid out in the EPA 2015 Report 159 - Ensemble of regional climate model projections for Ireland . Together with Met Éireann and the EPA, ICHEC will seek to update this research by incorporating the high resolution historical climate data from the Met Éireann Reanalysis project (MÉRA) to update the validation results laid out in this report, as well as using more up-to-date climate models and scenarios.
Photograph	
Budget	Not available
Climate Change Vulnerability and Risks	As it is not an infrastructure, but a research project, it does not have potential vulnerabilities or risks. It is highly useful however for identifying potential vulnerabilities and risk in a multitude of sectors.
Climate change adaptation measures	The data from the MÉRA project will potentially provide a greater degree of accuracy for transport stakeholders in identifying future areas of vulnerability within key transport infrastructure.
Good practice	A Climate Information Portal will be established through which the updated climate insights will be made available for wider research and to the general public. It is anticipated that the portal will be maintained by Climate Ireland.
Further information	http://www.epa.ie/pubs/reports/research/climate/research159ensembleofregionalclimatemodelprojectionsforireland.html

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