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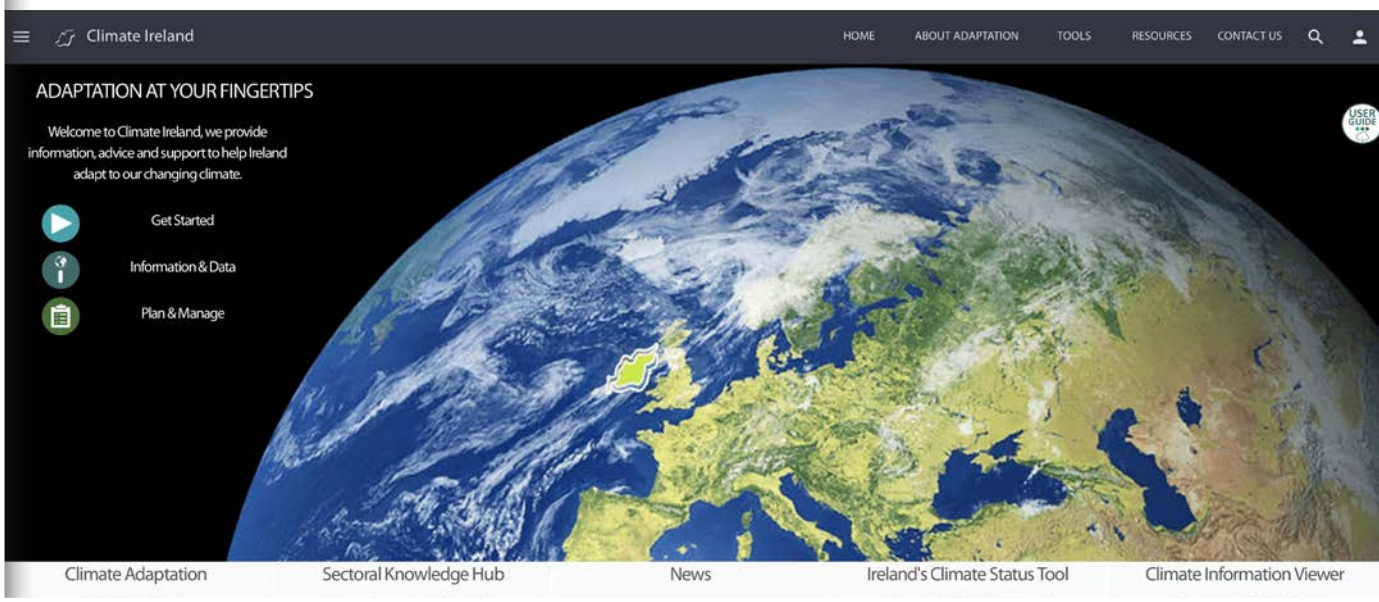
Report No. **258**

The Development of an Irish Climate Information Platform (ICIP) - Phase 3 (2015-2017)

Authors: Barry O'Dwyer, Mohammad Hashemi and Jeremy Gault



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Rialtas na hÉireann
Government of Ireland

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

The work of the EPA can be divided into three main areas:

Regulation: *We implement effective regulation and environmental compliance systems to deliver good environmental outcomes and target those who don't comply.*

Knowledge: *We provide high quality, targeted and timely environmental data, information and assessment to inform decision making at all levels.*

Advocacy: *We work with others to advocate for a clean, productive and well protected environment and for sustainable environmental behaviour.*

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- intensive agriculture *(e.g. pigs, poultry)*;
- the contained use and controlled release of Genetically Modified Organisms *(GMOs)*;
- sources of ionising radiation *(e.g. x-ray and radiotherapy equipment, industrial sources)*;
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- Generating greater environmental awareness and influencing positive behavioural change by supporting businesses, communities and householders to become more resource efficient.
- Promoting radon testing in homes and workplaces and encouraging remediation where necessary.

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The EPA is managed by a full time Board, consisting of a Director General and five Directors. The work is carried out across five Offices:

- Office of Environmental Sustainability
- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet regularly to discuss issues of concern and provide advice to the Board.

EPA RESEARCH PROGRAMME 2014–2020

The Development of an Irish Climate Information Platform (ICIP) – Phase 3 (2015–2017)

(2015-CCRP-MS.28)

EPA Research Report

Prepared for the Environmental Protection Agency

by

Centre for Marine and Renewable Energy Ireland, Environmental Research Institute,
University College Cork

Authors:

Barry O'Dwyer, Mohammad Hashemi and Jeremy Gault

ENVIRONMENTAL PROTECTION AGENCY
An Ghníomhaireacht um Chaomhnú Comhshaoil
PO Box 3000, Johnstown Castle, Co. Wexford, Ireland

Telephone: +353 53 916 0600 Fax: +353 53 916 0699
Email: info@epa.ie Website: www.epa.ie

ACKNOWLEDGEMENTS

This report is published as part of the EPA Research Programme 2014–2020. The EPA Research Programme is a Government of Ireland initiative funded by the Department of Communications, Climate Action and Environment. It is administered by the Environmental Protection Agency, which has the statutory function of co-ordinating and promoting environmental research.

The authors would like to acknowledge the members of the project steering committee, namely John O'Neill (Department of Communications, Climate Action and Environment), Seamus Walsh (Met Éireann), Roger Street (UK Climate Impacts Programme), Margaret Desmond (EPA), Frank McGovern (EPA), Philip O'Brien (EPA) and Karen Roche (Project Manager on behalf of EPA Research). The insights of those who attended workshops and conference presentations were also invaluable to the project team.

Cover images: image 1 – Storm Ophelia, Ringaskiddy (photo by Ollie Aldert); image 2 – road closures as a result of freezing conditions experienced in Cork City, 2nd March 2018 (photo by Barry O'Dwyer); image 3 – Climate Ireland portal.

DISCLAIMER

The EPA Research Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

EPA RESEARCH PROGRAMME 2014–2020
Published by the Environmental Protection Agency, Ireland

ISBN: 978-1-84095-795-2 September 2018

Price: Free Online version

Project Partners

Barry O'Dwyer
MaREI Centre
Environmental Research Institute
University College Cork
Co. Cork
Ireland
Tel: +353 21 486 4326
Email: b.odwyer@ucc.ie

Jeremy Gault
MaREI Centre
Environmental Research Institute
University College Cork
Co. Cork
Ireland
Tel: +353 21 486 4305
Email: j.gault@ucc.ie

Mohammad Hashemi
MaREI Centre
Environmental Research Institute
University College Cork
Co. Cork
Ireland
Tel: +353 21 486 4389
Email: mohammad.hashemi@ucc.ie

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Executive Summary

The global climate is changing as a result of human influences; the impacts of these changes are already being felt across all continents and oceans and are expected to continue and intensify for many decades to come. Between 1880 and 2012, the global average temperature increased by 0.8°C; this increase is largely attributed to emissions of greenhouse gases (GHGs) since the industrial revolution. Each of the last three decades has been successively warmer than any preceding decade since 1850 and the period from 1983 to 2012 was probably the warmest 30-year period of the last 1400 years in the northern hemisphere. In order to address the impacts of climate change, two complementary policies have been adopted: mitigation and adaptation. Mitigation aims to reduce and eliminate emissions of GHGs and enhance carbon sinks. The long-term goal of the Paris Agreement is to "achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of the century". Because of the inertia within the climate system, however, which takes centuries to adjust to changes in the concentrations of GHGs, the benefits of present and ongoing efforts to mitigate GHG emissions will not be felt for many decades to come. Therefore, to prevent or minimise the adverse impacts of climate, planned and anticipatory adaptation to climate change and the impacts of these changes is now required.

Adaptation has been defined by the Intergovernmental Panel on Climate Change 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 natural systems, human intervention may facilitate adjustment to expected climate and its effects." This simply means anticipating and planning for the effects of climate change and taking appropriate actions to offset or minimise the adverse impacts of these changes while taking advantage of any opportunities that they might bring.

For Ireland, there now exists a large and growing body of work on observed and projected climate changes and associated impacts and it is considered that there is a robust knowledge to support the process of adaptation planning. Because of the disparate nature of this information, however, it is extremely difficult for decision makers and citizens alike to access it. Contemporary international experience has demonstrated that centralised online platforms providing access to harmonised scientific information adapted to user needs can effectively support practical decision making. On this basis, the Environmental Protection Agency (EPA) Science, Research, Technology and Innovation for the Environment (STRIVE) Programme (2007–2013) identified the need for a national climate change information system for Ireland.

Adopting a phased approach to development, the EPA-funded project, Ireland's Climate Information Platform (ICIP), aims to develop a climate information platform (CIP) for Ireland to provide decision makers with a one-stop web-based resource of climate and adaptation information for Ireland. ICIP Phase 1 (2010–2013), awarded under the EPA STRIVE Programme, identified the best technical options for the design of an information platform, established agreements with data holders and determined the needs of the end-user community in order to develop a prototype platform. ICIP Phase 2 (2013–2015, EPA funded) built on the existing CIP prototype, improving its usability and expanding its capabilities with the specific aim of supporting local-level decision making for climate adaptation. This has involved upgrading the prototype technically in terms of the underpinning data and data management, by improving the front-end of the CIP prototype and by developing tools to assess climate change impacts in order to support decision makers.

ICIP Phase 3 (2015–2017, EPA funded) was awarded to develop user-centred information, guidelines and decision supports for sectoral decision making for climate adaptation. ICIP Phase 3 also aimed to increase users' capacity in the application of the CIP prototype to adaptation planning through the provision of user-focused training. Increasing the uptake of ICIP was also a key aim of Phase 3 development, through the enhancement of the existing CIP prototype and the continued promotion of ICIP as Ireland's key

support for climate adaptation planning. This has been achieved through a partnership approach with project stakeholders. By the end of the project:

- Sectoral guidelines for adaptation decision making have been produced, which are underpinned by resources and tools made available through the CIP prototype. In addition, and notably, the guidelines have been employed by sectoral planners in Ireland as a basis for the development of their adaptation plans.
- A series of 2-day regional Local Authority Adaptation Training Workshops were developed and delivered to enhance capacities amongst local authorities for adaptation planning, supported by the CIP prototype. The workshops, which were attended by 93 local authority representatives, were well received and enhanced the uptake of the CIP prototype.
- The CIP prototype has been significantly enhanced through ICIP Phase 3 development in terms of both quality of experience (QoE) and quality of service (QoS). Improvements to the QoE were achieved through the development of an enhanced CIP front-end, the implementation of a responsive design and an improved navigation design. Improvements to QoS were achieved in co-operation with the allied ICIP technical project and involved the migration, deployment and optimisation of the CIP prototype to servers at the Irish Centre for High-End Computing (ICHEC). This has resulted in the increased performance, reliability and security of the CIP prototype.
- The promotion of ICIP as the key national resource for adaptation planning was successfully delivered through a wide range of collaboration, outreach and dissemination activities as it formed a key focus of ICIP Phase 3 development.

ICIP development to date (Phases 1–3) has made substantial progress in developing a CIP specifically tailored to the needs of adaptation decision making in Ireland and has demonstrated the potential for employing existing information and data in meeting the challenge of initiating, planning for and managing climate change adaptation. However, to further develop and increase the uptake of ICIP for the purposes of spatial and sectoral planning for adaptation to climate change, there is a requirement for continued development in a number of key areas:

- Adaptation is a new area of planning for spatial and sectoral planners in Ireland. As a result, climate and adaptation information and decision supports made available through ICIP will need to evolve in line with the requirements of decision makers as they progress through the key stages of adaptation decision making and as their understanding of the scope and nature of the risks and vulnerabilities and the adaptation required progresses.
- ICIP has demonstrated its effectiveness as a boundary resource working at the science–policy interface and in supporting decision making for climate adaptation. Considering the needs of stakeholders has formed a critical component of development and it is essential that consideration of the evolving needs of stakeholders forms a key component of any future development.
- ICIP has played a key role in increasing the capacity of spatial and sector decision makers in planning for climate change adaptation. In order to increase the utility and uptake of ICIP and for the purposes of initiating, developing and delivering adaptation plans, there is a continued requirement to increase capacities amongst spatial and sectoral planners to employ the CIP in the development of their adaptation plans.
- Through three phases of development, ICIP has been funded on a project basis; in order to ensure the continued update and development of the CIP prototype by stakeholder groups, a strategic roadmap is required to sustain this key infrastructure and this should be underpinned by policy-supported mechanisms for funding.

1 Introduction

1.1 Climate Change

Global climate is changing as a result of human influences. The impacts of these changes are evident across all oceans and continents and are expected to continue and intensify for many decades to come. Between 1880 and 2012, the global average temperature increased by 0.8°C; this increase is largely attributed to emissions of greenhouse gases (GHGs) since the industrial revolution. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850 and, in the northern hemisphere, 1983–2012 was probably the warmest 30-year period of the last 1400 years (IPCC, 2013).

As a result of past and present emissions of GHGs from various sectors, we are now committed to a substantial climate change for many decades to come, regardless of ongoing efforts to limit GHG emissions. This is because of the inertia within the climate system, which takes centuries to adjust to changes in concentrations of GHGs. Therefore, to prevent or minimise the adverse impacts of climate, planned adaptation to climate change and the impacts of these changes is now required. This means anticipating and planning for the effects of climate change and taking appropriate actions to offset or minimise the adverse impacts of these changes while taking advantage of any opportunities that they might bring.

1.2 Climate Change and Impacts for Ireland

Research has improved our understanding of ongoing and projected climate change for Ireland and has provided critical insights into how climate change will impact us into the future (e.g. Flood and Sweeney, 2012; Walsh, 2012; Gleeson *et al*., 2013; Nolan, 2015). Observed changes in Ireland's climate are in line with global trends (Figure 1.1). As detailed in Table 1.1, temperatures are increasing, sea levels are rising and seasonal patterns of storms and precipitation are changing (Dwyer, 2012).

Projections indicate that this trend will continue and intensify into the future: Ireland's climate will become warmer and drier, rates of sea level rise will increase and the magnitude and frequency of extreme weather events is also expected to increase (Nolan, 2015; EEA, 2017a). These changes and associated impacts will have a wide range of consequences for Ireland's economy and society, both adverse and beneficial. For example, in terms of adverse impacts, increasing sea levels and potential increases in levels of storminess will result in increased levels of coastal inundation and erosion. Furthermore, climate change is expected to result in an increase in the frequency of extreme events, with potentially devastating consequences. In contrast, projected changes in climate will also offer opportunities for some sectors of the Irish economy.

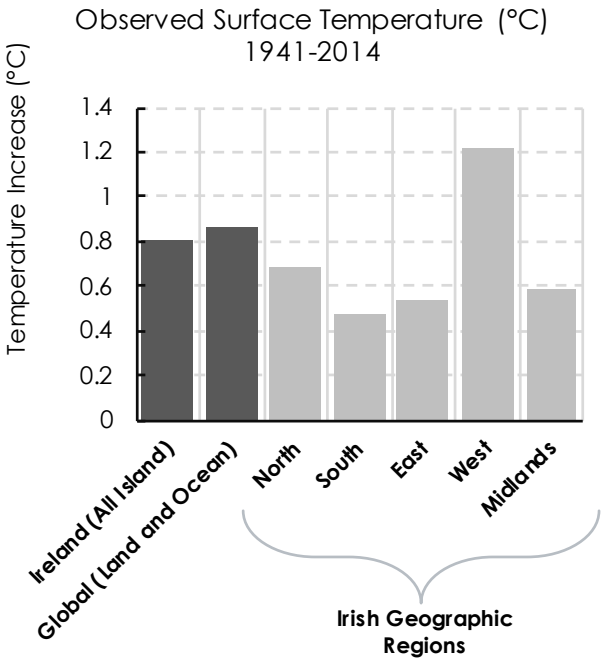

Figure 1.1. Temperature increase over the period 1941–2014 for Ireland and globally. The grey bars further illustrate observed temperature changes for different geographical regions in Ireland (Met Éireann). Source: National Oceanic and Atmospheric Administration's National Centers for Environmental Information, Climate at a Glance Time Series, https://www.ncdc.noaa.gov/cag

Table 1.1. Summary of observed and projected climate changes for Ireland, with examples of potential impacts

Parameter	Observed	Projected	Example of biophysical impacts
 **Temperature**	Average temperatures have increased by 0.8°C over the period 1900–2011 The number of warm days (over 20°C) has increased whereas the number of cold days (below 0°C) has decreased (Dwyer, 2012)	Projections indicate an increase in average temperatures across all seasons (0.9–1.7°C) (Nolan, 2015) The number of warm days is expected to increase and heat waves are expected to occur more frequently (Nolan, 2015)	Incidences of cold stress are likely to decrease whereas incidences of heat stress will increase The duration of the growing season will increase, with it occurring earlier and extending farther
 **Precipitation**	Compared with the period 1961–1990, levels of annual average rainfall have increased (5%) for the period 1981–2010 The largest increases have been observed over the west of the country (Dwyer, 2012)	Significant reductions are expected in average levels of annual, spring and summer rainfall (Nolan, 2015) Projections indicate a substantial increase in the frequency of heavy precipitation events (approx. 20%), particularly during winter (Nolan, 2015)	The increased occurrence of dry spells will result in increased pressure on the water supply An increase in the frequency of extreme precipitation events will result in increased fluvial and pluvial flood risk
 **Wind speed and storms**	No long-term change in average wind speed or direction can be determined with confidence (Dwyer, 2012) The number and intensity of storms in the North Atlantic has increased in recent decades (IPCC, 2014) The number of these storms tracking over Ireland has remained variable (Dwyer, 2012)	Projections indicate an overall decrease in wind speed and an increase in extreme wind speeds, particularly during winter (Nolan, 2015) The number of very intense storms is projected to increase over the North Atlantic region. Projections suggest that the winter track of these storms may extend further south and over Ireland more often (Nolan, 2015)	Increases in extreme wind speeds may impact on wind turbines and the continuity of the power supply Infrastructure will be at risk because of the increased occurrence of intense storms (e.g. winter 2013/2014)
 **Sea level and sea surface temperature**	Sea levels are rising at approx. 3.5 cm per decade in the coastal areas surrounding Ireland, with the greatest increases recorded for the Irish Sea (Dwyer, 2012) Sea surface temperatures have increased by 0.7°C since 1850, with an unprecedented rate of warming since 1994 (0.6°C per decade) (Dwyer, 2012)	Sea levels will continue to rise for all coastal areas, by up to 0.8 m by 2100. The south of Ireland will probably feel the impacts of these rises first (EEA, 2014a) Sea surface temperatures are projected to continue warming in the coming decade. For the Irish Sea, projections indicate a warming of 1.9°C by the end of the century (Olbert *et al.*, 2012)	Significant increase in areas at risk of coastal inundation and erosion Increased risk to coastal aquifers and water supply Change in the distribution of fish species Implications for fisheries and aquaculture industries

For example, projected increases in temperature and potentially drier summers will prolong the present peak tourism season into the shoulder months of April, September and October and allow for diversification of tourism activities (Salmon, 2010).

1.3 Climate Action

As at COP 21, held in Paris in 2015 (UNFCCC, 2015), climate change is now recognised as a global challenge with policy responses required in terms of both mitigating the causes of climate change and adapting to the now inevitable consequences of these changes (Figure 1.2). The first policy pursued in response to climate change, mitigation, has been defined as "A human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs)" (IPCC, 2014) and aims to limit climate warming through the reduction of GHG emissions and the increase in carbon sinks. Because of latencies in the response of the climate system, however, even if contemporary actions aimed at mitigating the causes of climate change are successful, many of the impacts are locked in for some decades to come and are expected to continue and intensify. The second policy response, adaptation, aims to better prepare society to cope with, manage or adjust to changing climatic conditions and has been defined by the IPCC (2014) 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."

Adaptation policy in the European Union (EU) is relatively new and is being progressed through the EU Adaptation Strategy [EC, COM (2013) 216] (EC, 2013). A key objective of this strategy is to encourage all Member States to adopt adaptation strategies, in turn providing the policy context for the development of adaptation plans and integrating adaptation measures into local and sectoral activities. To date, 25 European Environment Agency members have adopted a National Adaptation Strategy, including Ireland through the first and non-statutory National Climate Change Adaptation Framework (NCCAF) (DECLG, 2012), and 17 have developed a National Adaptation Plan (EEA, 2014b, 2017b). This initial NCCAF from 2012 aims to ensure that adaptation actions to reduce Ireland's vulnerability to climate change impacts are taken across key economic sectors and also at the local level. The NCCAF called for the development and implementation of sectoral and local adaptation plans, which form part of the national response to the impacts of climate change.

Following from the first NCCAF, the Climate Action and Low Carbon Development Act 2015 (Government of Ireland, 2015), Ireland's first dedicated climate change law, put the development of a National Adaptation Framework (NAF) and sectoral and local adaptation plans on a statutory basis. Developed by the Department of Communications, Climate Action and Environment (DCCAE), the NAF (DCCAE, 2018)

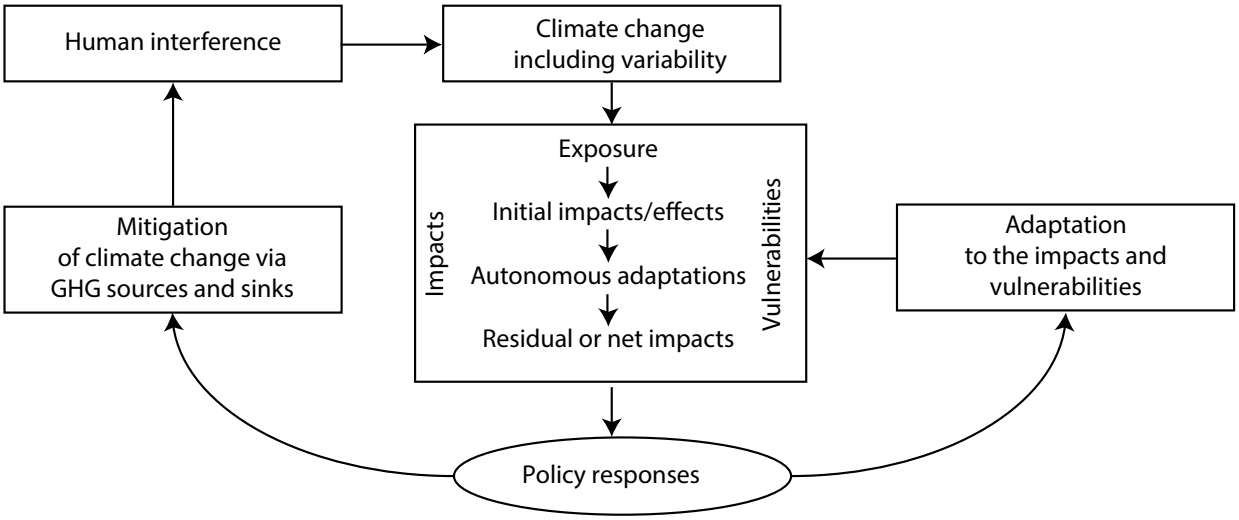

Figure 1.2. Summary diagram illustrating policy responses (mitigation and adaptation) to climate change.

provides for the preparation of sectoral and local adaptation plans and specifies the national strategy for the application of all measures (sectoral and local) to reduce the vulnerability of the state to the negative effects of climate change. Under the Act, the evolution of the NAF will be an iterative process (reviewed every 5 years) and will be based on the adoption of a series of these national frameworks for the period to 2050.

1.4 Delivering Adaptation Responses

Until recently, decision makers in Ireland tended to rely on past records of climate to plan for the future. In the context of planning for the future including projected climate changes, basing plans on past records will prove inadequate and information is now required on how human-induced warming may affect key climatic parameters and the impacts of these changes for Ireland. Arriving at an understanding of current and future climate change impacts at this scale is a major challenge for decision makers and requires consideration of a wide range of potential impacts, where and when these may occur and their consequences for different elements of Ireland's society, environment and economy.

The adaptation policy cycle (Figure 1.3) provides a framework to assist decision makers in overcoming this challenge and in developing climate adaptation plans. The first step in the cycle is an assessment of risks and vulnerability, followed by an examination of adaptation options. The next step is to implement the adaptation options and the final step is to monitor and evaluate the actions. Once this first iteration is complete, the cycle can begin again with a reassessment of risks and vulnerability that includes the results of the evaluation of measures introduced in the previous iteration. The steps in the cycle can then be reconsidered periodically to ensure that adaptation decisions are based on the most up-to-date data and knowledge and the evolving socio-economic and political context. In addition, the iterative nature of this process allows for monitoring and an assessment of the successes and failures of adaptation actions (EEA, 2013).

1.5 Climate Information Platforms

As adaptation policy progresses in Europe and in Ireland, it is increasingly important that decision makers have access to relevant and high-quality information that can be used to support the development of national and transnational adaptation strategies and plans as indicated in, and guided by, the EU Adaptation Strategy [EC, COM (2013) 216] (EC, 2013). Web-based platforms are considered an important tool within that strategy and can be a vital means of sharing information, evidence and experience of key stakeholders in adaptation. Importantly, web-based platforms are being employed as a one-stop repository of information, data and knowledge to support those preparing for and adapting to the consequences of climate change. These data and information would otherwise be distributed across a wide range of different agencies, institutions and organisations. Their existence also seeks to reflect the cross-sectoral nature of climate change risk and responses and the need to avoid duplicate and

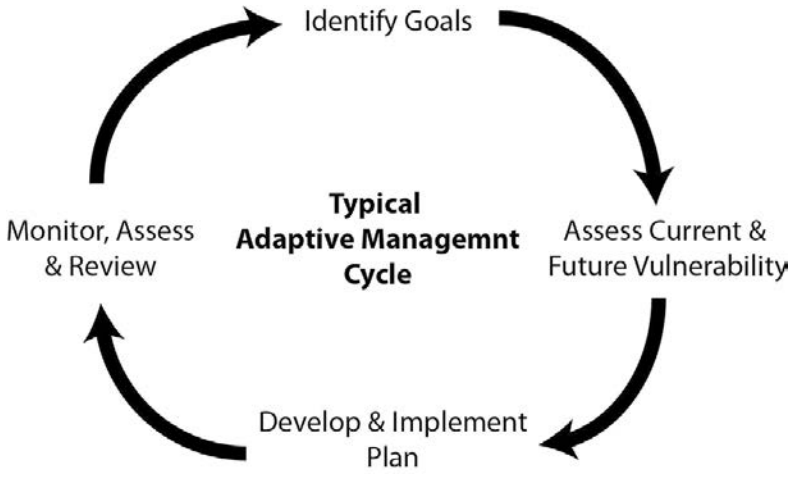

Figure 1.3. Schematic diagram of a typical adaptive management cycle.

conflicting information from multiple and in some cases disjointed sources.

Currently, in Europe, many national governments have supported the development of national adaptation platforms and 14 national platforms have been established; there are also three transnational platforms and one at EU level. The adaptation platform landscape, however, is dynamic and the nature of individual platforms varies depending on their history, policy context, remits, target audiences and resources. These differences are reflective of the diverse range of platform stakeholders (funders and operating agencies) and the range of interests, needs and capacities of the target audiences (e.g. policymakers, sectoral organisations, practitioners, researchers and businesses). As a result, the content being shared by these web-based platforms varies according to the specific needs and decision environment in which they operate but often includes policy action at transnational, national and subnational levels, scientific bases, research results, guidance, decision support tools and experiences from practice and implemented adaptation measures (case studies) (EEA, 2015).

1.6 Ireland's Climate Information Platform

Ireland now has a significant amount of information on a wide range of climate variables, including an understanding of observed and projected changes in these variables and in turn a growing understanding of the expected impacts of climate change. In parallel to the establishment of a sound climate impact knowledge base, policy progress is being made in rising to the challenges posed by climate change using well-established approaches to developing mitigation strategies, as exemplified by the National Climate Change Strategy (DECLG, 2007), the National Policy Position on Climate Action and Low Carbon Development (DECLG, 2014), the Climate Action and Low Carbon Development Act (2015) and the National Mitigation Plan (DCCAE, 2017a). Policy in the area of adaptation has also been progressed through the publication of the NCCAF and more recently through the Climate Action and Low Carbon Development Act (2015) and the statutory NAF (2018). These measures provide a strategic policy focus to ensure that adaptation measures are taken across all sectors and levels of governance to reduce Ireland's vulnerability to the impacts of climate change. More specifically, under the NAF, the relevant government departments, state agencies and local authorities are mandated to commence the preparation of sectoral and local adaptation plans.

Currently, in Ireland, the implementation of adaptation is in its infancy and in order to enable planning for climate change adaptation, and more specifically for the preparation of sectoral and local adaptation plans, access to robust, harmonised and easy-to-use data and tools with which to analyse them are required. There is therefore a need for a "one-stop shop" climate information platform (CIP) where all relevant climate information, data and tools can be brought together and accessed in a user-friendly way by a range of stakeholders. However, the development of a one-stop shop is challenging and there are a number of institutional, technological, design and data challenges. For example, different policies regarding data access operate in different organisations. Technologies are constantly evolving and any architecture developed will need to be flexible. It is imperative that the interface design of any information system is driven by user opinion and experience and is informed by their needs. Addressing data issues in relation to volumes, quality, restrictions, completeness, reliability and other relevant criteria is thus a significant challenge.

The first "discovery" phase (Phase 1) of development of Ireland's Climate Information Platform (ICIP) made substantial progress in addressing the challenges described above, providing a one-stop shop resource of climate information and data for Ireland and having the potential to serve as a key resource for communicating and supporting the analysis of climate impacts, vulnerability and adaptation options (www.climateireland.ie). With the support of the Department of Environment, Community and Local Government, the second phase of development (ICIP Phase 2) further developed the ICIP Phase 1 resource and was specifically targeted at supporting local authorities in the preparation and development of their adaptation plans/strategies. For example, the Local Authority Adaptation Wizard support tool (http://tiny.cc/CI_localtool) was developed through ICIP Phase 2 to facilitate climate adaptation decision making amongst local authorities and in accordance with the requirements of the NCCAF. In addition, ICIP Phase 2

made progress in increasing understanding and awareness of adaptation amongst decision-making communities and the general public.

This report describes the third phase of development (Phase 3), which will build on the existing prototype, developed under ICIP Phases 1 and 2, to produce and enhance ICIP, with the specific aims of supporting sectoral decision making for climate change adaptation and in accordance with the requirements of the NCCAF and the statutory NAF (2018); ensuring the continued utility and therefore uptake of ICIP by spatial and sectoral planners in Ireland through the provision of user training and support for ICIP and climate adaptation; and facilitating the migration and optimisation of ICIP for operational deployment.

2 Supporting Sectoral Decision Making for Climate Adaptation

Ongoing and projected climate change is having, and will continue to have, a wide range of impacts on Ireland's key economic sectors. Within individual sectors, a range of consequences, both positive and negative, may be present. For example, milder winters would probably benefit the agriculture sector because of less frost, but this benefit may be offset by heatwaves/droughts during the summer months. Other changes and impacts may benefit some sectors positively and other sectors negatively. For example, projected changes in average and extreme wind speeds will potentially have negative implications for the wind energy sector, whereas other sectors may benefit from reduced damage to infrastructure, houses and so forth. Finally, for other changes and impacts, it is difficult to conceive positive consequences for any of the sectors. For example, projected rises in sea level will put coastal infrastructure and communities at risk, whereas projected increases in the occurrence of extreme precipitation events will increase fluvial and pluvial flood risk further in land.

As a result, integrating adaptation considerations into sectoral decision making is a key aim of Ireland's Low Carbon and Climate Action Development Act 2015 and NAF (2018). This is because policy formulation at the sectoral level is considered a key entry point for adaptation, as it co-ordinates numerous and ongoing sectoral initiatives and informs the implementation of investments and activities. On this basis, the development of sectoral guidelines for adaptation decision making was a key aim of ICIP Phase 3. The development of the guidelines has been informed by international best practice (e.g. EEA, 2013; Gray, 2015; Buth *et al*., 2017) and carried out in close consultation with the Department of Transport, Tourism and Sport (DTTAS), the Department of Agriculture, Food and the Marine (DAFM) and the National Adaptation Steering Group. In addition, the guidelines have been employed by DTTAS and DAFM in the development of draft adaptation plans, demonstrating their utility in sectoral adaptation planning. The following provides an overview of the developed sectoral guideline document and the associated web-based supports for sectoral adaptation decision making; the full guidelines can be accessed through the CIP prototype.

2.1 Sectoral Adaptation Guidelines

The guidelines aim to ensure that a coherent and consistent approach to adaptation planning is adopted at national and local scales that draws on existing sources of climate and adaptation information (e.g. the CIP prototype). The guidelines are structured around a six-step planning cycle: (1) preparing the ground; (2) climate impact screening; (3) prioritisation; (4) priority impact assessment; (5) develop your plan; and (6) implement, monitor and review. As illustrated in Figure 2.1, it is important to note that, although these steps appear as sequential, adaptation decision making is an iterative process. Moreover, moving backwards or forwards to revisit a step or anticipate a future step may also be appropriate.

The emphasis of the guidelines is on a staged and proportionate approach to adaptation planning:

- The early steps (1 and 2) focus on preparing the ground for an effective adaptation planning process and identify what changes and impacts have the potential to give rise to wider and unacceptable sectoral impacts.

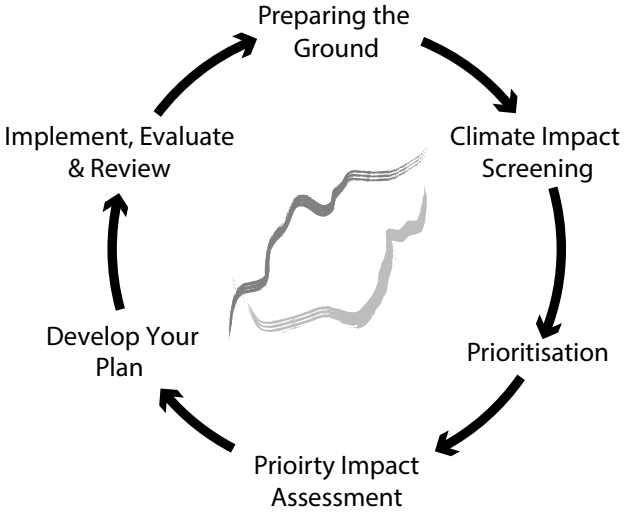

Figure 2.1. Schematic diagram of the adaptation planning process with the six key steps indicated.

- Following from this, step 3 involves prioritising ongoing and potential future climate impacts and vulnerabilities in the context of sectoral and policy objectives/targets.
- Step 4 builds on the scoping stage and examines those changes and impacts considered a sectoral priority and involves a more thorough assessment of exposure, sensitivity and adaptive capacity (i.e. vulnerability).
- Steps 5 and 6 involve identifying a series of goals, objectives and actions, thus shifting the focus from potential impacts and vulnerabilities to adaptation.

2.1.1 Step 1: preparing the ground

To ensure that the foundations for designing and delivering an effective adaptation planning process are established, it is essential that a number of key elements are put in place at the start of the process. This includes establishing a Sectoral Adaptation Team (SAT), identifying stakeholders and their roles and securing required human, technical and financial resources.

At the outset of the adaptation planning process, it is essential that a suitably qualified and experienced SAT is put in place to oversee and undertake the adaptation planning process. The SAT should consist of a Core Team, which will co-ordinate and oversee the adaptation planning process, and a Planning Team (PT), which will ensure that a broad spectrum of relevant knowledge, know-how and technical expertise is considered in the development of the adaptation plan. It is important to note that, as the adaptation planning process progresses, the PT can be expanded to incorporate additional know-how, interests and skills as and when required. For example, findings and actions from the adaptation plan will have practical implications for a broad spectrum of stakeholders, including local authorities, emergency response services and public health services. In addition, and to ensure coherence of plans across sectors, representatives from other sectors that will be affected by the plan or actions arising from it should also be included in the PT.

The level of resources that can be brought to bear on the adaptation planning process will determine the scope and limitations of the plan. At the outset of the process, it is important to secure the required human, technical and financial resources. As a result, the inclusion of a member or representative of senior management is necessary.

Expected output: A fit-for-purpose, knowledgeable and adequately resourced adaptation PT.

2.1.2 Step 2: climate impact screening

Because of the wide-ranging nature of climate change, developing an understanding of the full range of sectoral vulnerabilities to climate change and the impacts of these is important. The is achieved through climate impact screening, the purpose of which is to develop a broad understanding of sectoral vulnerability and the consequences of ongoing and future climate impacts and to collect all of the relevant preliminary information to allow for the prioritisation of the most urgent climate vulnerabilities for further and more detailed analysis.

As part of this screening, recent sectoral experiences of weather- and climate-related impacts form the focus and the baseline for the assessment of the potential consequences of future climate changes. Once an understanding of sectoral vulnerability to and consequences of current and ongoing weather- and climate-related impacts has been developed, an assessment of how projected changes in climate might exacerbate or ameliorate current levels of vulnerability is undertaken. The potential for projected changes to result in any new climate impacts and vulnerabilities is also assessed. At this stage of planning, and when undertaking this screening assessment, employing national-level statements of observed and projected changes in climate is appropriate, e.g. Climate Ireland – Essential Climate Information (http://tiny.cc/CI_EsCimateInformation) and Met Éireann - Major Weather Events (https://www.met.ie/climate/major-weather-events).

Expected output: A wide-ranging understanding of ongoing and potential future sectoral vulnerability.

2.1.3 Step 3: prioritisation

On the basis of identified sectoral vulnerabilities, climate impacts and vulnerabilities are prioritised for further and more detailed analysis. This prioritisation is a critical step that will be used to focus adaptation efforts and set sectoral goals and the associated actions required to meet them.

The prioritisation exercise will highlight those impacts and vulnerabilities that will have the greatest sectoral consequences. As part of this prioritisation, all stakeholders should be consulted and the results of the climate impact screening should be presented and discussed. Those impacts, vulnerabilities and risks considered of greatest concern are then prioritised for further analysis. Criteria that might help this prioritisation include the timing of any impact, the magnitude of the impact and the relevance of the impact to sectoral activities, priorities and objectives.

Expected output: Climate impacts and vulnerabilities considered as a sectoral priority.

2.1.4 Step 4: priority impact assessment

As the potential climate impacts and vulnerabilities that are likely to affect a sector have now been identified and prioritised, this step involves developing a more detailed understanding of those impacts and vulnerabilities considered a sectoral priority. The goal is to develop a range of plausible climate change outcomes (impacts and consequences) based on multiple time horizons and on multiple emission levels that can provide the basis for further analysis and decision making. This involves employing more detailed climate information that provides an assessment of spatial and temporal variations in projected changes in key climate parameters and associated uncertainties, e.g. Climate Ireland – Climate Information Tool (http://tiny.cc/CI_viewer).

Expected output: A more detailed understanding of priority climate risks, illustrated through a case study example.

2.1.5 Step 5: develop the plan

On completion of the priority impact assessment, an understanding of vulnerabilities, the relative priorities and where and when the sector wants to direct its adaptation efforts will have been developed. The adaptation plan will consist of establishing goals, sequencing objectives and identifying and prioritising actions to implement the plan. In addition, the plan will identify the risks, barriers and enablers associated with the implementation of identified adaptation options. It is likely that no single adaptation action will achieve all of the objectives and that a variety of actions will be required. Adaptation actions can be usefully classified into those that will address current sectoral impacts and vulnerabilities (e.g. those related to coastal inundation), those that will build capacity to implement, monitor and evaluate the actions being introduced and those that address emerging and future climate-related impacts and vulnerabilities (e.g. temperature-related impacts).

Expected output: A list of adaptation goals, objectives and actions.

2.1.6 Step 6: implement, evaluate and review

The final step of planning involves the implementation, monitoring and evaluation of the plan. This includes ensuring that the plan is widely disseminated, tracking and evaluating the progress of the plan and its components, communicating the plan's progress and updating the plan. It is also important to remember that climate science is evolving and that other political, social, economic and technological changes are occurring and, to account for this, the planning process will have to be an ongoing process and flexible. It should also be recognised that changes in other sectors, including those directly or indirectly resulting from the adaptation actions, will need to be considered in the evaluation of the plan.

Expected output: A plan for implementing, monitoring and reviewing the adaptation plan.

2.2 Web-based Support for Sectoral Adaptation Decision Making

To support sectoral decision making for climate change adaptation, a number of web-based supports have been implemented through the CIP prototype as part of ICIP Phase 3 development. A dedicated entry point for sectoral users has been included on the home page of the CIP prototype, which accesses a dedicated sectoral resource page (Figure 2.2). This allows users to quickly orient themselves with the information pertinent to sectoral planning on the CIP prototype, which includes relevant policy and legislation and key resources (e.g. ICIP's Sectoral Adaptation Tool) and tools (e.g. ICIP's Sectoral Adaptation Support Wizard).

To support sectoral planning for climate change adaptation, a Sectoral Adaptation Tool has been developed and deployed through the CIP prototype

(Figure 2.3). The tool serves to complement the sectoral guidelines for adaptation planning and supports users in taking full advantage of and integrating the different sources of information made available through the CIP prototype in the development of their adaptation plans. The tool breaks down each of the six key steps of the sectoral adaptation planning cycle into a number of tasks. For each task, the tool provides a description of the task, the process to be employed in undertaking the task and the required outputs. In addition, the tool provides users with worksheets to support the collection of the information required for the development of the adaptation plan.

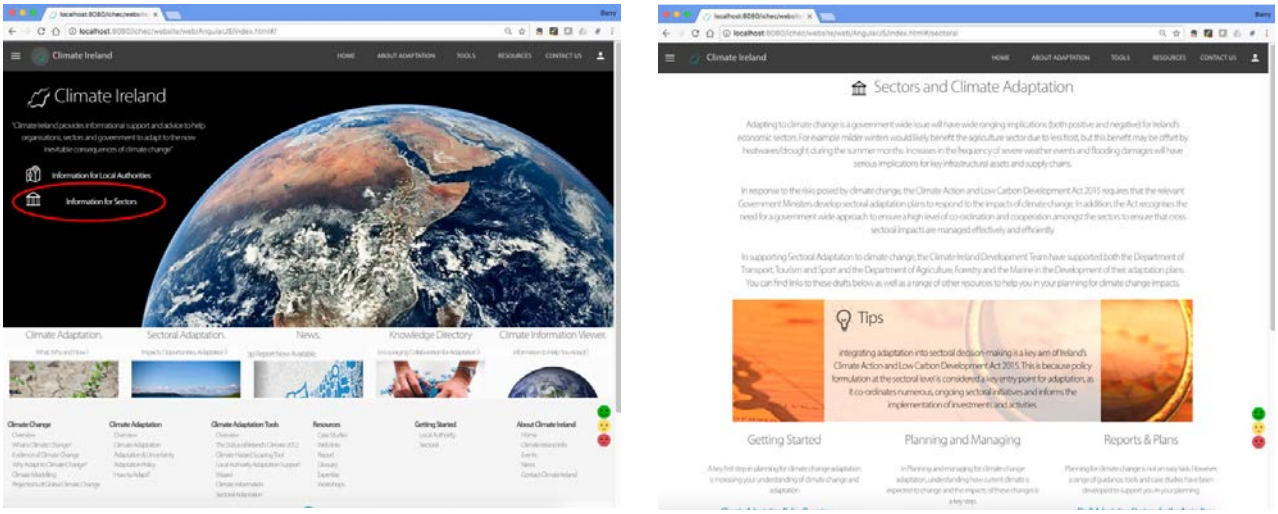

Figure 2.2. Left: screenshot of the Phase 3 CIP home page with the sectoral entry point indicated; right: a screenshot of the sectoral resource area.

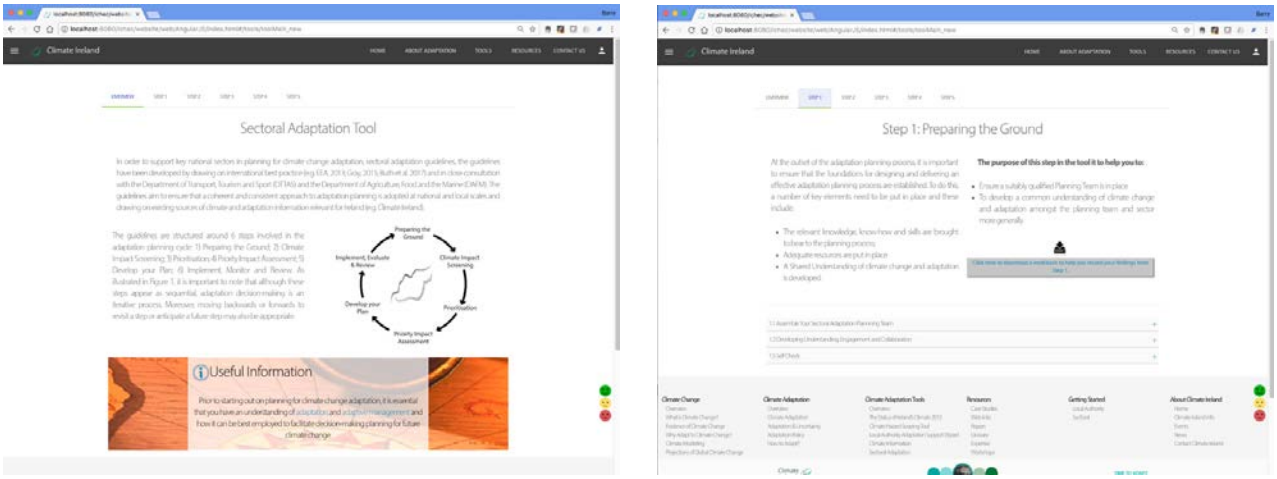

Figure 2.3. Left: screenshot of the Sectoral Adaptation Tool; right: screenshot of an individual step of the sectoral adaptation tool.

3 User Training and Support

The impacts of climate change will manifest and be differentiated at national, regional and local scales. As a result, the NCCAF (DECLG, 2012), the Climate Action and Low Carbon Development Act (Government of Ireland, 2015) and the NAF (2018) call for a co-ordinated and multi-level governance response underpinned by adequate and appropriate measures at sectoral and local levels. For example, local authorities, in their role as local community leaders, decision makers, employers and providers of services and goods, have a critical role to play in planning for adaptation to climate change. For Ireland, it has been recognised that there now exists enough information to begin the process of adaptation planning (Shine and Desmond, 2011). In addition, guidelines (e.g. Gray, 2015) and tailored decision support frameworks have now been developed to assist local-scale decision making for climate change adaptation (e.g. ICIP's Local Authority Adaptation Support Wizard). Planning for climate change adaptation, however, represents a new area of planning for local authorities and there now exists a requirement to increase awareness amongst local authorities about the need for planned adaptation responses. There is also a corresponding need to increase the capacity of local authorities to effectively employ available adaptation planning supports (e.g. ICIP's Local Authority Adaptation Support Wizard) in planning for future climate change impacts and implementing adaptation responses.

To support local authorities in developing climate change adaptation plans and in accordance with the requirements of the NCCAF (2012) and the NAF (2018), a training programme was designed and delivered that was specifically tailored to the requirements of local authorities in Ireland and aimed to develop capacity amongst local authorities for adaptation planning. The programme included workshops that were aimed at staff within local authorities who are developing local climate adaptation plans. Workshop delivery was supported by the DCCAE and, in total, 93 local authority staff members attended across the national Regional Assemblies held in the following locations:

- South and West Regional Assembly (SWRA), Centre for Marine and Renewable Energy (MaREI), University College Cork (UCC), 14–15 September 2016.
- Eastern and Midlands Regional Assembly (EMRA), Local Government House, Dublin, 4–5 October 2016.
- Northern and Western Regional Assembly (NWRA), Offices of the NWRA, Roscommon, 26–27 October 2016.

The workshops were developed on the basis of adopting a hands-on approach to adaptation planning and were designed around the adaptation decision-making cycle (see Figure 1.3). The aim was to introduce participants to key climate adaptation principles and provide practical experiences of adaptation planning. In doing so, the workshops also sought to understand knowledge and capacity gaps and barriers to effective adaptation decision making in Ireland.

3.1 Workshop Structure

Each workshop was delivered over 2 days to allow sufficient time for participants to become familiar with the key concepts – no prior knowledge of climate change or climate adaptation was assumed. As summarised in Figure 3.1, each workshop was divided into four inter-linked sessions and associated facilitated breakouts, which were structured around the key steps of the adaptation decision-making cycle. Each breakout was divided into three working groups.

3.1.1 Session 1: increasing understanding

The first session aimed to provide the scientific and policy context and requirements for adaptation planning at the local level in Ireland. The session consisted of a series of presentations by relevant experts (Figure 3.2) followed by a panel discussion. Presentations focused on ongoing and projected climate changes and impacts for Ireland, adaptation policy and available resources. In addition, participants were introduced to examples of existing adaptation plans (e.g. Edinburgh's Adaptation Plan) to gain an insight into the development approaches adopted in other jurisdictions.

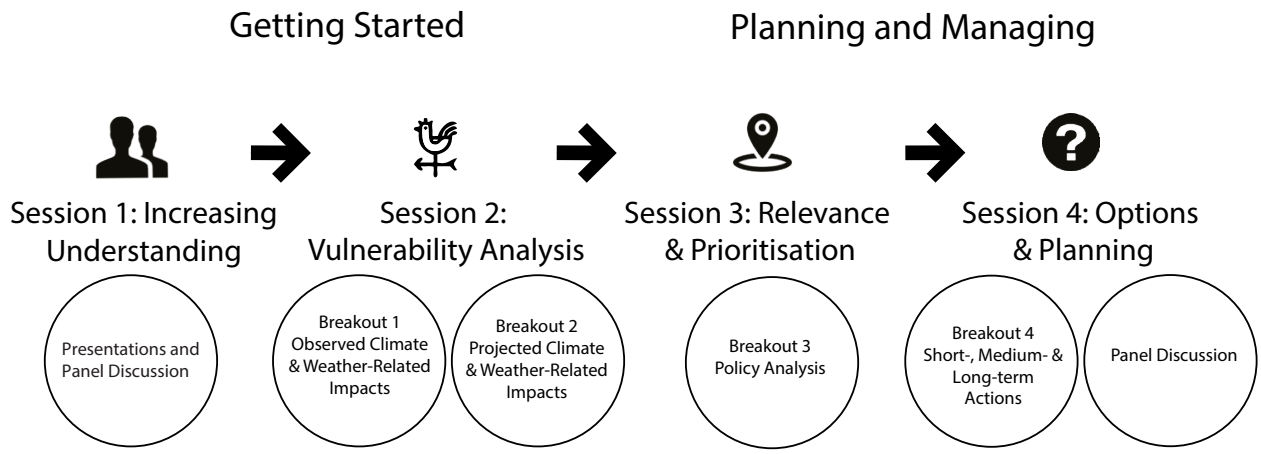

Figure 3.1. Outline of workshop sessions and associated breakouts. The relevant step of the adaptation decision-making cycle is also shown.

Figure 3.2. Top: John O'Neill (DCCAE) presents the policy context for adaptation in Ireland at the NWRA; bottom: Anna Beswick (Adaptation Scotland) provides an overview of Edinburgh's Adaptation Action Plan at the EMRA.

3.1.2 Session 2: vulnerability analysis

The second session aimed to highlight the requisite information required to instigate the development of climate adaptation plans and equip participants with the key skills required to derive this information. This involved familiarising participants in the identification of the known range of current and potential future climate impacts affecting their local authorities. The session consisted of two introductory presentations and two facilitated breakouts:

- Breakout 1: Employing existing and observed climate information for Ireland (e.g. Walsh, 2012), participants were tasked with identifying the impacts and consequences of current and ongoing changes in Ireland's climate and extreme weather events. Each working group aimed to assess impacts and consequences related to three priority climate changes and impacts (Figure 3.3).
- Breakout 2: Employing projected climate change information for Ireland (e.g. Nolan, 2015), this breakout aimed to scope how the current and ongoing impacts of climate change might increase or decrease under projected changes in Ireland's climate and whether or not the region may be subject to any new or emerging climate impacts in the future.

Figure 3.3. Top: example of breakout 1 activities at the SWRA; bottom: an example output from breakout 1 activities at the EMRA.

In both breakouts, working groups adopted a vulnerability approach and recorded their findings on a map. For each of the climate change impacts examined the vulnerability framework employed involved identifying three key criteria:

1. the area exposed to the weather- and climate-related impacts;
2. the key sensitivities (environmental, social and economic) to these impacts;
3. current levels of adaptive capacity (response measures).

3.1.3 Session 3: relevance and prioritisation

The third session aimed to identify the relevance of identified vulnerabilities (observed and potential future) to the services and functions of local authorities and prioritise these impacts for adaptation action. This session consisted of an instructional presentation and was followed by a third breakout that aimed to identify relevant policy, aims and objectives that might be impacted on by ongoing and projected climate changes, as identified during breakouts 1 and 2 (Figure 3.4, top).

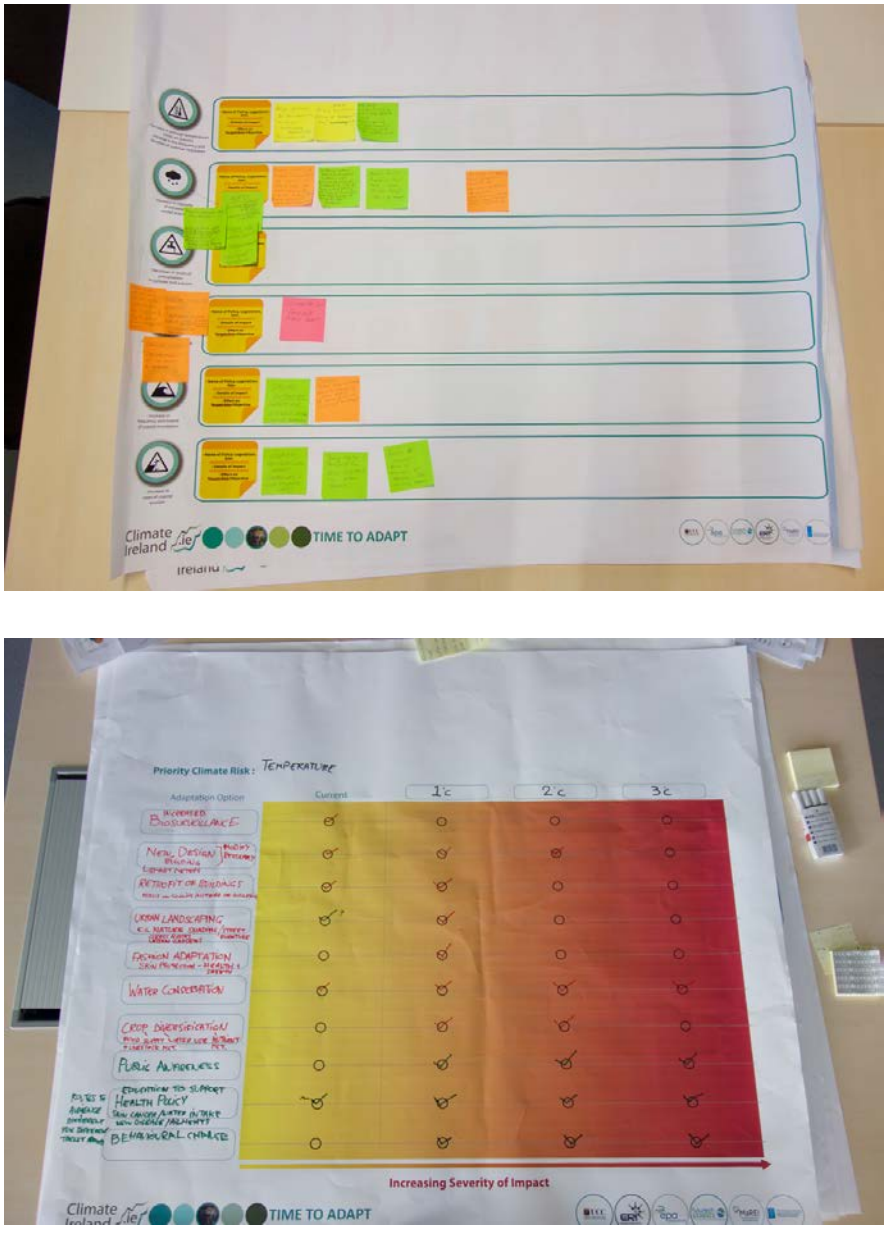

Figure 3.4. Top: an example output from breakout 3 activities at the SRA; bottom: an example output from breakout 4 activities at the EMRA.

3.1.4 Session 4: adaptation options and planning

The fourth session aimed to familiarise participants with different adaptation options based on international and national examples of adaptation measures. Additionally, this session aimed to establish which options could potentially be employed to address the vulnerabilities prioritised in breakout 3 and identify timelines for their implementation. This was delivered through a fourth breakout and involved the identification of potential adaptation measures to offset the adverse impacts of climate change and maximise any opportunities that these changes might bring (Figure 3.4, bottom). When considering adaptation options, participants considered those that aimed to build adaptive capacity and deliver adaptation action. Adaptation options for potential implementation in the medium to long term were first identified; these were then used to subsequently identify short-term adaptation options that would be required to support the implementation of identified medium- to long-term options. In addition, policies and practices that could enable or act as barriers to the required adaptation were identified and discussed, as well as those adaptation measures that could act as synergies for delivery of adaptation or even act in conflict with proposed measures (and vice versa).

3.1.5 Overview of workshop outcomes

The following provides an overview of the workshop results; O'Dwyer *et al*. (unpublished) contains a more comprehensive description of the workshop and outcomes.

The workshop results indicate that the impacts of climate change are already being felt at the local level, with implications for the provision of services and functions by local authorities. In relation to the impacts of current climate changes and extreme weather events, priority impacts for local authorities are associated with extreme weather events (freezing events, coastal and inland flooding and storms), with the impacts of periods of climate variability (sea level rise and above average temperatures) also a concern. For projected climate changes, additional and emerging impacts were associated with increasing temperatures and decreases in annual average levels of precipitation. These changes will have implications for the achievement of a wide range of policy aims and objectives related to the maintenance and improvement of water quality and supply (e.g. Water Framework Directive, 2000/60/EC), biodiversity (e.g. Habitats Directive, 92/43/EEC), roads (e.g. signage and lighting), energy (National Energy Efficiency Action Plan; DCCAE, 2017b), emergency planning and corporate and economic planning (e.g. economic development priorities).

To offset the adverse impacts and take advantage of any opportunities presented by these changes, a range of adaptation actions (green, soft and hard) were identified for implementation in the medium to long term. A number of actions were, however, identified as being a prerequisite requirement for these, for implementation in the short term. These included:

1. the development of a national framework that provides clear guidance on how adaptation is to be implemented at the local level;
2. the development and delivery of awareness-raising programmes for local authorities, their executives and the general public;
3. the further and continued development of local authorities' capacity to undertake the adaptation planning process;
4. the development of mechanisms to establish the evidence base/business case for adaptation action;
5. the establishment of multi-authority teams to develop spatially coherent adaptation plans through a regional approach;
6. the establishment of mechanisms to facilitate learning and exchange between local authorities.

3.2 Workshop Evaluation

The workshop programme and delivery were assessed through an evaluation survey (Figure 3.5). Of the 93 local authority staff who attended the workshops, 49 completed the evaluation survey (53% response rate). As illustrated in Figure 3.5, the results of the survey suggest that participants found the workshops clear and easy to follow and that the workshops made participants more aware of how to carry out adaptation.

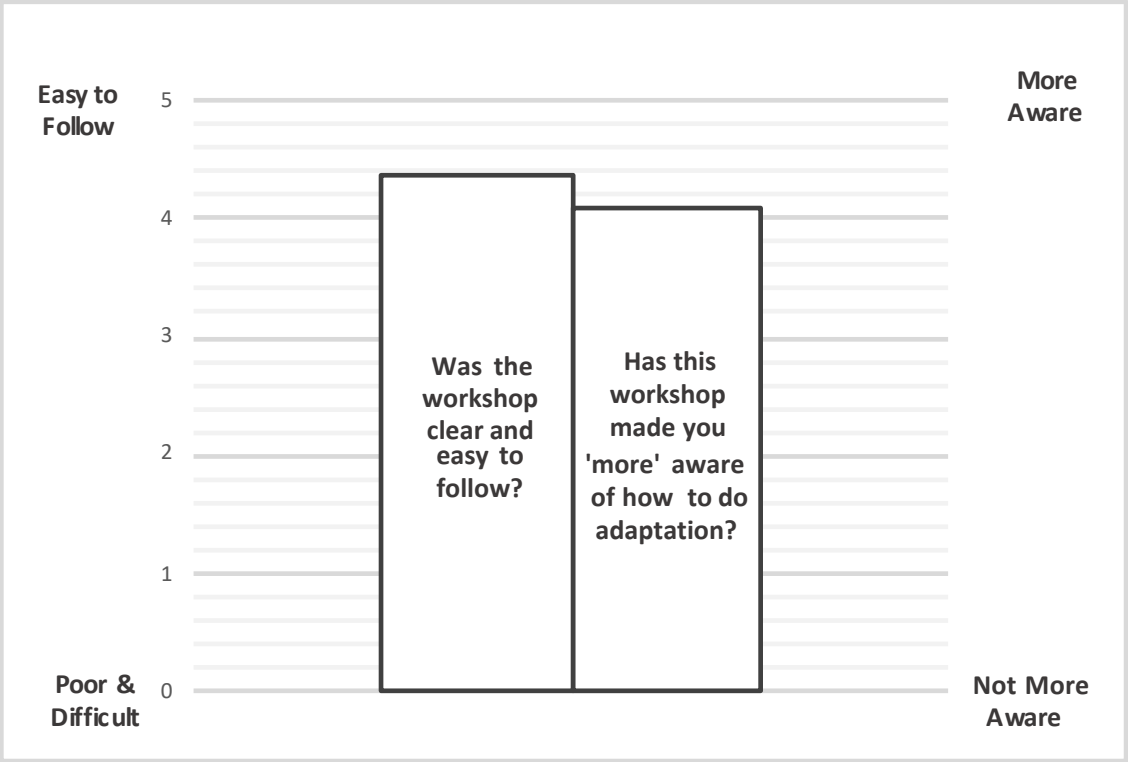

Figure 3.5. Survey results from three regional local authority adaptation training workshops.

In particular:

- The participants noted that the workshops made complex issues easier to understand and relevant at the local level.
- The combination of presentations and working sessions was well received by participants and broke the issue down into doable tasks.
- The participants noted that more examples of on-the-ground adaptation are required.

4 Optimisation and Migration of ICIP

As part of ICIP Phase 3 development, the CIP prototype has been upgraded substantially in terms of both quality of experience (QoE) and quality of service (QoS). Improvements to QoE have been achieved through significant upgrades to the CIP prototype aesthetic and system architecture whereas improvements to the QoS have been achieved in close collaboration with the allied ICIP Phase 3 Technical Project and through the migration, integration and deployment of the CIP prototype to servers at the Irish Centre for High-End Computing (ICHEC). Following from this, ICHEC has collaborated on data processing and provided technical and infrastructure support.

4.1 Quality of Experience

Phase 3 development of ICIP has resulted in three significant improvements to the QoE, by:

1. upgrading the aesthetic and responsiveness of the CIP prototype;
2. implementing improved navigation and feedback mechanisms;
3. upgrading the prototype Climate Information Viewer.

4.1.1 Aesthetic and responsiveness

As illustrated in Figure 4.1, and in order to respond to users' behaviour and available technologies, the ICIP front-end has been upgraded significantly to allow for an enhanced aesthetic and a responsive web design. This has been achieved through the upgrading of the system architecture to AngularJS, a web application developed by Google, which allows for the development of cross-platform applications, i.e. responsive design. In addition, through two-way data binding, the implementation of AngularJS has resulted in decreased loading times.

4.1.2 Navigation and feedback mechanisms

To support users in navigating the CIP prototype and finding the information that they require; a multi-level navigation architecture has been implemented (Figure 4.2). This includes a primary/main navigation scheme that provides access to the key elements of the CIP prototype (Home, About Adaptation, Tools, Resources and Contact Us) and is located at the top of each page of the CIP prototype. The primary navigation scheme is complemented by navigation in the footer of the page that guides users towards key informational resources (e.g. news, Climate Information Tool). Secondary navigation is provided through a sidebar and also through a sitemap. This secondary navigation breaks down the primary/main navigation scheme into sub-headings. In addition, a number of entry points designed to meet the needs of specific users have been included in the prototype (e.g. local authorities and sectors). These entry points allow users to access the most pertinent information for their needs in a single click. In addition, a notification controller has been implemented that notifies users when they complete a task (e.g. log in) or need to take an action (information alerts).

To support users in providing feedback to the ICIP development team, a more user-friendly, language-independent feedback mechanism has been implemented through the prototype. This feedback mechanism consists of a traffic light system by which users can rate each page of the CIP prototype. Importantly, this feedback is relevant to the satisfaction of users with individual web pages rather than the entire CIP prototype.

4.1.3 Climate Information Viewer

The Climate Information Viewer is an important component of the CIP prototype and has been further upgraded through ICIP Phase 3 developments (Figure 4.3). This has involved development of both the ICIP system structure and front-end and has included enhancements to the overall aesthetic of the Climate Information Tool, loading times and compatibility.

Previously, in ICIP Phase 2 implementation, on request, the CIP prototype retrieved requested data (i.e. processed data) from the Climate Core Database and provided this data to the front-end, which

was responsible for styling data (using Openlayer Version 2). This resulted in poor load speeds and inadequate performance. Through ICIP Phase 3 development, as illustrated in Figure 4.4, this process has been improved to decrease load times, improve performance and allow for inclusion of a wide range of data types. In the new implementation, raw netCDF files (i.e. climate data) are processed and sent to the Climate Core Database using OPeNDAP. When a user requests data through the CIP prototype, the request is

Figure 4.1. Screenshots of implementation of ICIP Phase 1 (top), ICIP Phase 2 (bottom) and ICIP Phase 3 (next page).

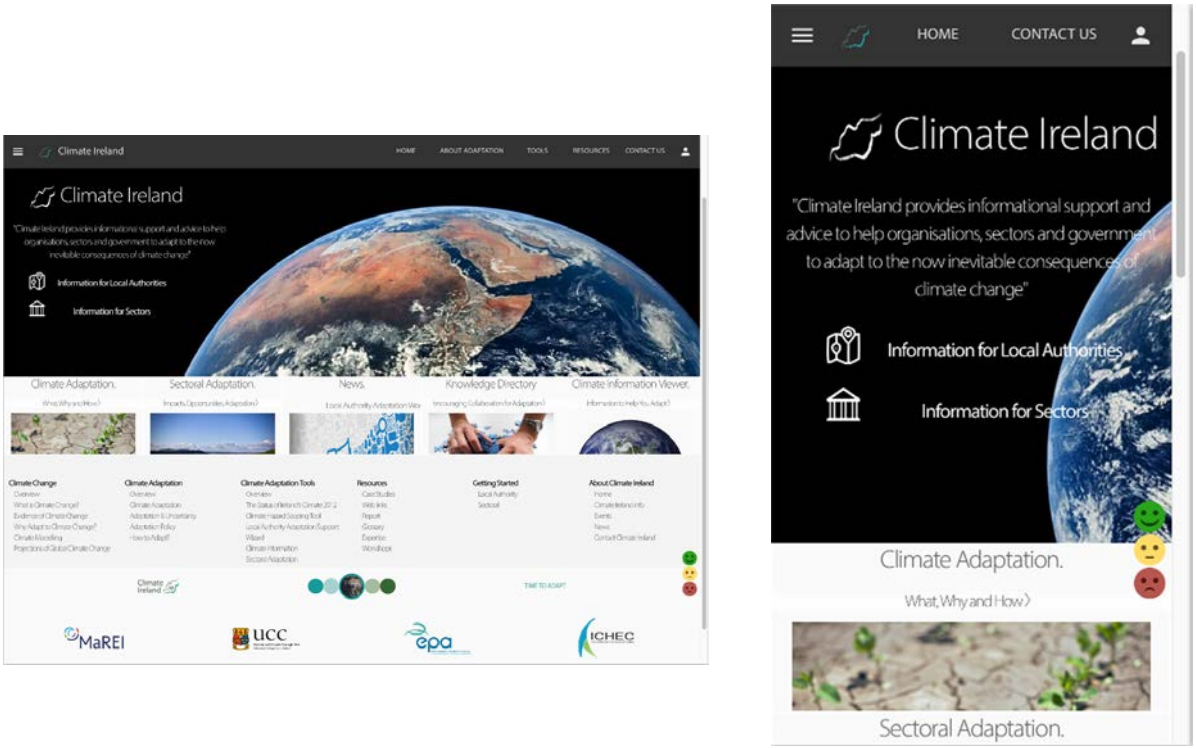

Figure 4.1. Continued. For ICIP Phase 3, both desktop (left) and smartphone (right) implementations are shown.

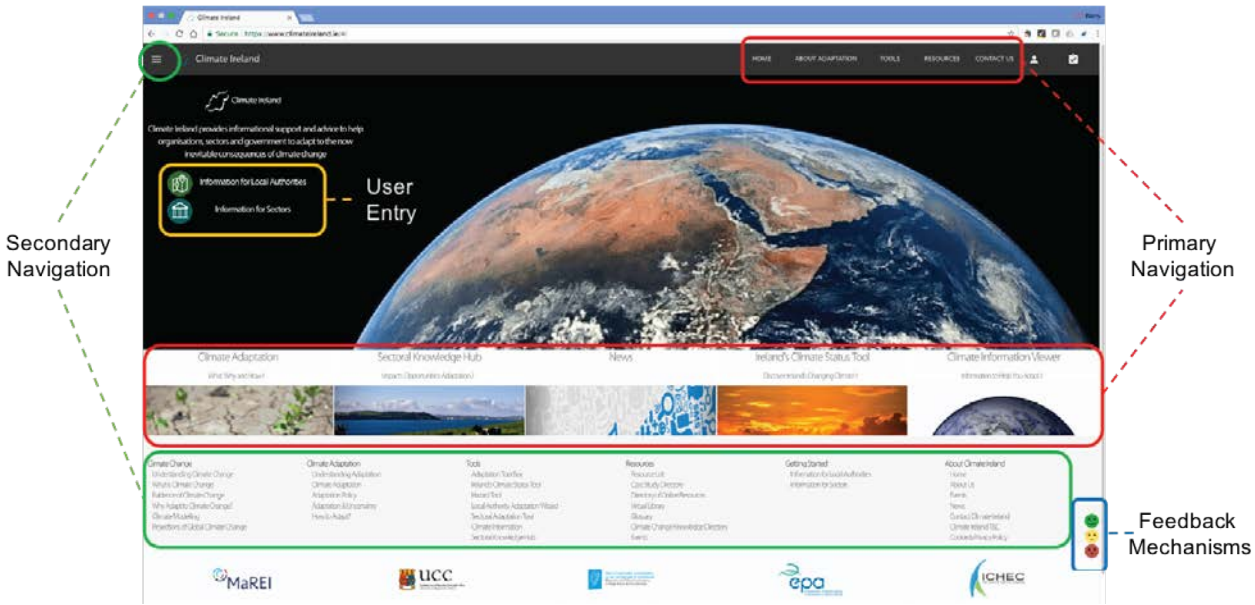

Figure 4.2. Screenshot of ICIP Phase 3 implementation with navigation and feedback mechanisms indicated.

sent to Geoserver, which then retrieves the data from the Climate Core Database, styles the data and sends this data to the Climate Information Viewer for display. In addition, ICIP Phase 3 implementation allows for publishing of processed data from the Climate Core Database as netCDF files and for upload to the Earth Systems Grid Federation (ESGF) system.

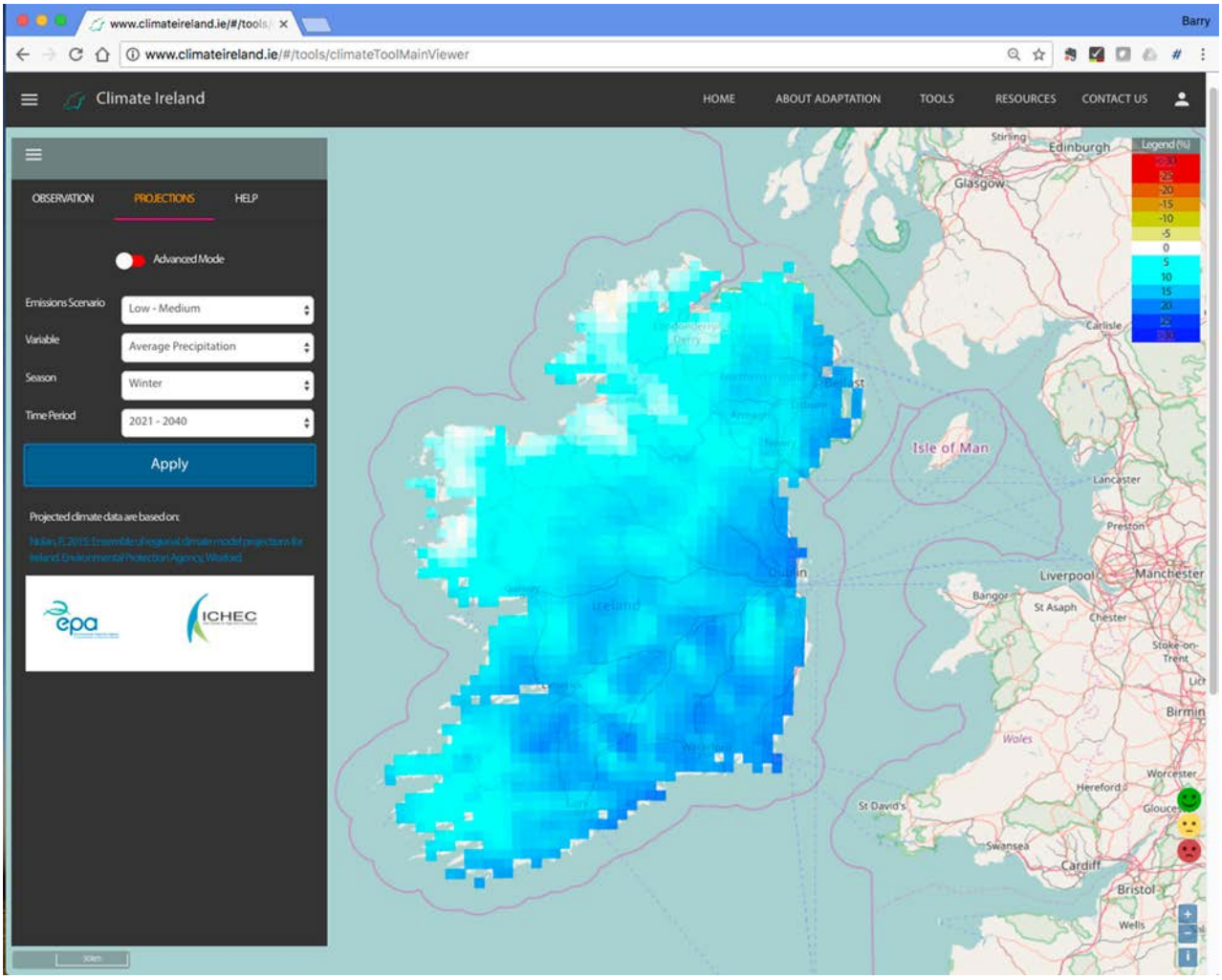

Figure 4.3. A screenshot of the ICIP Phase 3 prototype Climate Information Viewer implementation.

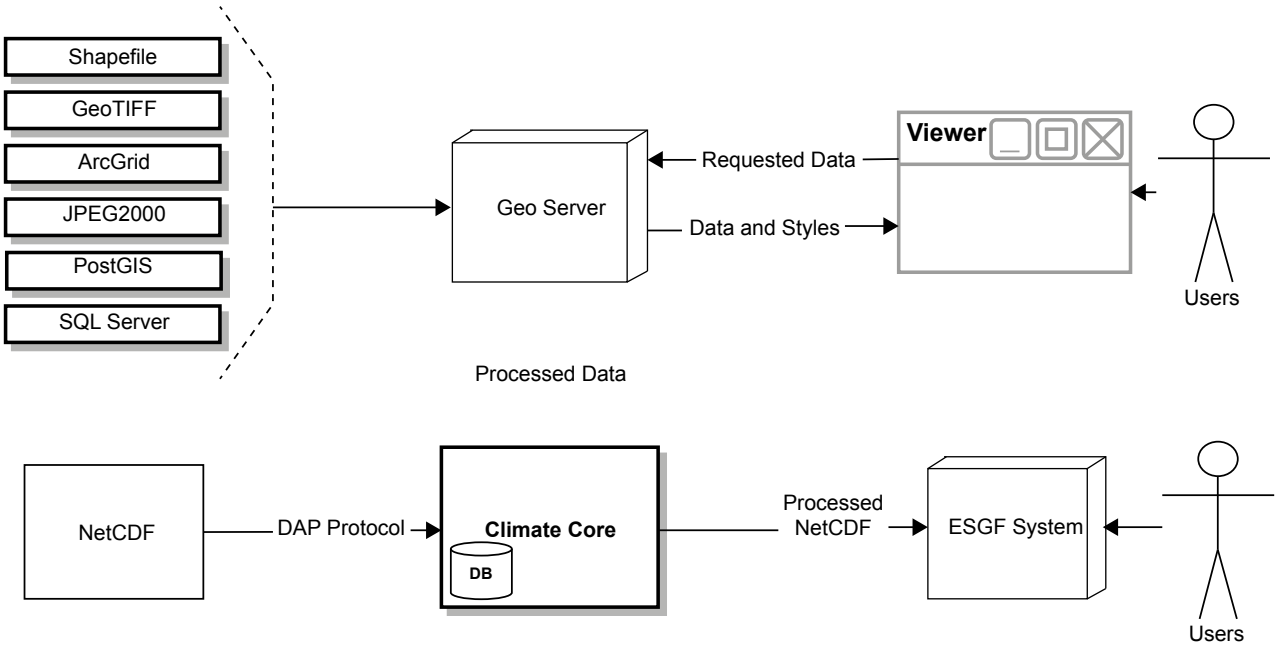

Figure 4.4. A schematic diagram of the ICIP Phase 3 implementation of the CIP prototype system architecture. DAP, Directory Access (Protocol).

4.2 Quality of Service

In close collaboration with the ICIP Phase 3 Technical Project, the QoS has improved substantially. This has involved the migration and deployment of the CIP prototype to servers located at ICHEC, which has resulted in increased performance and the implementation of enhanced security and back-up measures.

4.2.1 Migration and deployment

The ICIP Phase 3 prototype has been migrated, integrated and set up within the ICHEC infrastructure. In accordance with best operational practice, the prototype has been deployed on multiple servers, i.e. geoserver, repository and database management software now all have their own dedicated servers, which results in increased performance, manageability, security and scalability. In addition, to improve workflow for publishing new content (i.e. to reduce bugs that reach the end user), four environments of the CIP prototype have been deployed at ICHEC (Figure 4.5).

1. The development server is the working environment for the development team and is held locally at UCC. Once initial development is completed, these developments are committed to the integration server.
2. Integration is a common environment where all developers (UCC and ICHEC) can commit changes. The goal of this environment is to combine and validate all changes so that they can be tested before being promoted to the development (staging) environment.
3. Development is an environment that is as identical to the production environment as possible; the purpose of this environment is to simulate as much as possible the production environment. The development environment can be used for demonstration and testing.
4. The production environment is the final publically available CIP prototype.

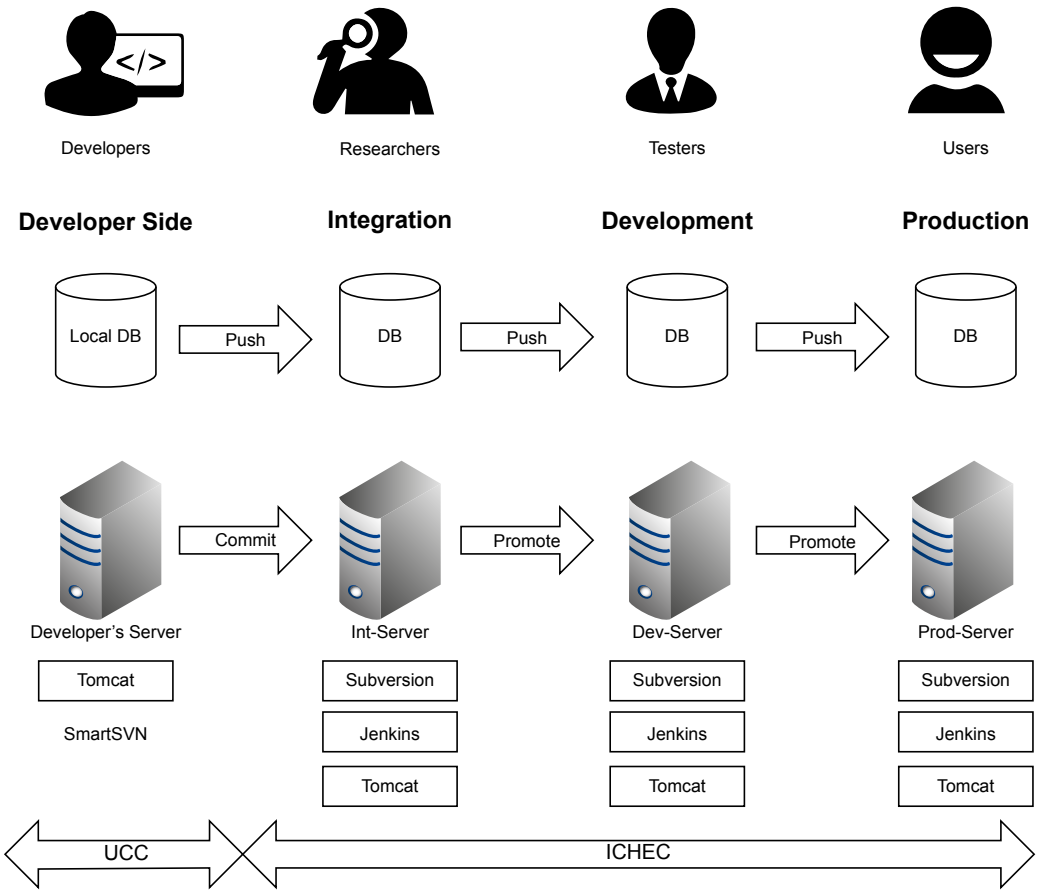

Figure 4.5. A schematic diagram of the ICIP Phase 3 development workflow. DB, database.

4.2.2 Increased security and back-up measures

To upgrade the security of the CIP prototype, the prototype has been upgraded from HTTP (Hypertext Transfer Protocol) to HTTPS (Hypertext Transfer Protocol Secure), providing three key layers of protection:

1. Encryption: all data exchanged is now encrypted, which means that, when a user is browsing the CIP prototype, nobody can listen to their conversations, track their activities or steal their information.
2. Data integrity: data cannot be modified during transfer, intentionally or otherwise.
3. Authentication: this proves that users communicate with the intended website and thus protects against man-in-the-middle attacks.

In addition, and to ensure continuity of the service in the event of a service failure, tape back-ups of the ICIP servers, databases and environments have been implemented on a daily basis.

5 Increasing the Uptake of ICIP and Assessing the Impact of ICIP Phase 3 Activities

5.1 Outreach, Dissemination, Communication and Engagement

To increase the uptake of the CIP prototype by spatial and sectoral planners and to promote the CIP prototype as Ireland's key and authoritative resource for planning for climate change adaptation, ICIP Phase 3 developments have involved a wide-ranging programme of outreach, dissemination and communication and engagement.

- In addition to the regional adaptation workshops for local authorities, and as part of ICIP Phase 3 development, ICIP has been demonstrated to a wide range of audiences, including at academic conferences (e.g. Adaptation Futures 2016, Rotterdam, 10–13 May; Annual Meeting of the European Meteorological Society, Dublin, 3–7 September), policymakers (e.g. Ireland's National Adaptation Steering Group and Sectoral Adaptation Committee), practitioners (e.g. Local Authority Services National Training Group, Irish Planning Institute) and the general public (e.g. FutureProof Wexford). In addition, ICIP has developed a bi-annual newsletter (Climate Ireland eNEWS), which has been distributed to over 300 subscribers.
- ICIP has played a key role in the development of transboundary collaborations and partnerships. For example, in collaboration with Climate Northern Ireland, ICIP has played a key role in establishing an All-Ireland Adaptation Partnership, which aims to connect all those working in the area of climate change and adaptation across the island of Ireland. In addition, ICIP has actively engaged with the UK administration's Climate Change Adaptation Liaison Forum, which includes representatives from England (Environment Agency), Scotland (Scotland and Northern Ireland Forum for Environmental Research – SNIFFER), Wales (Natural Resources Wales) and Northern Ireland (Climate Northern Ireland).
- The ICIP development team has actively engaged with researchers and practitioners working across Europe on the development of CIPs and has played a key role in convening sessions on the topic of CIPs at international conferences. For example, at the Adaptation Futures Conference (Rotterdam, 10–13 May 2016), the ICIP development team co-convened a session entitled "Adaptation Platforms in Action and Networks: The Practical Challenges and Lessons Learned from Designing and Operationalising Web-based Platforms".

5.2 Uptake of ICIP

As illustrated in Figure 5.1, ICIP Phase 3 developments have resulted in an increase in the number of unique users accessing the CIP prototype and have served to sustain the increasing trend in user numbers gained through ICIP Phase 2 development. In addition, the number of average annual sessions has increased from 2928 as part of ICIP Phase 2 to 4173 as part of ICIP Phase 3, representing an increase in both new and returning visitors despite the platform being still in its infancy. The number of users accessing ICIP using mobile devices has increased from 6% as part of ICIP Phase 2 activities to 13% as part of ICIP Phase 3 activities.

In assessing the impacts of ICIP Phase 3 activities on increasing user uptake, it is clear that outreach activities undertaken as part of project development are driving user uptake of ICIP. For example, the regional local authority adaptation training programme delivered as part of the ICIP Phase 3 activities (September to October 2016) resulted in an increase in the number of visitors to ICIP over the same period, with a peak of 479 unique monthly users evident in November 2016.

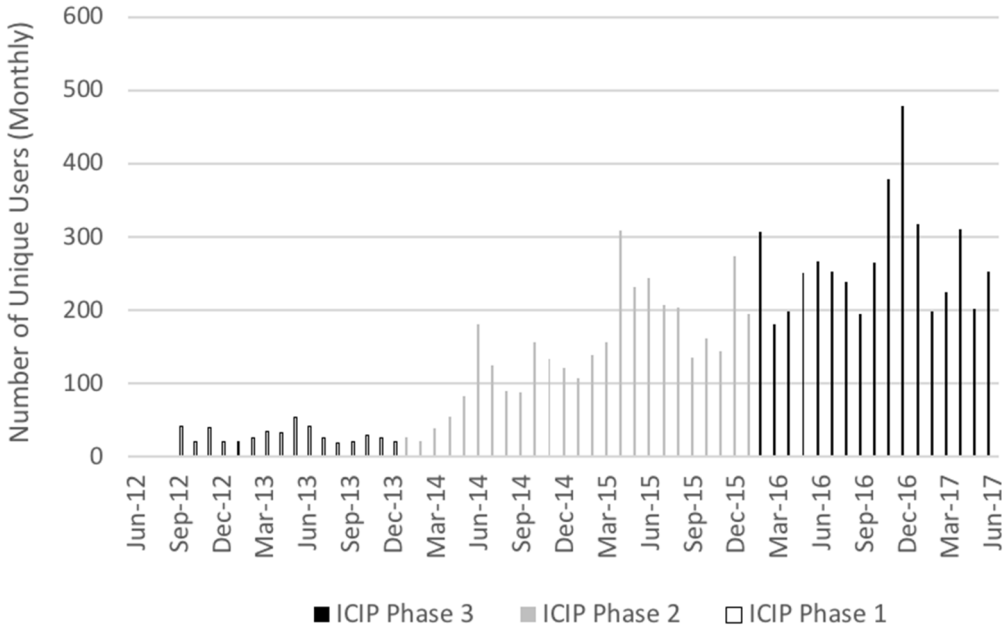

Figure 5.1. Number of unique users accessing the CIP prototype on a monthly basis.

6 Conclusions and Recommendations

6.1 Conclusions

The global climate is changing and these changes are expected to continue and intensify for the foreseeable future. Ireland's climate is already changing and is projected to change in line with global changes, with implications for all aspects of Ireland's environment, economy and society. Given the increased knowledge of ongoing and expected climate impacts, a planned and strategic approach to adaptation is now required to reduce risk and avail of any opportunities that these changes might bring. For Ireland, there now exists a wide range of information on ongoing and projected climate change and impacts and this information has the potential to provide a robust knowledge base on which to begin the process of adaptation planning. The information, however, is disparate in both location and format and is thus difficult for decision makers to access and interpret. International experience has demonstrated that centralised online CIPs providing harmonised scientific information tailored to the needs of the key stakeholder groups can provide effective support and enable practical climate adaptation decision making.

To date, ICIP development (Phases 1–3) has made substantial progress in developing a CIP specifically tailored to the needs of adaptation decision making in Ireland and has demonstrated the potential for employing existing information and data in meeting the challenge of initiating, planning for and managing climate change adaptation. More specifically, in ICIP Phase 1, substantial progress was made in developing a CIP prototype specifically tailored to the needs of adaptation decision making in Ireland, demonstrating the potential of the CIP prototype to act as a boundary resource, bridging the science–policy interface and making the information required for adaptation decision making available, relevant and usable by decision makers. Through ICIP Phase 2 development the CIP prototype was further developed by enhancing the system architecture, improving the usability of the prototype and providing additional functionality and tools (e.g. ICIP's Local Authority Adaptation Support Wizard).

In close collaboration with the project stakeholders, ICIP Phase 3 has supported the development of an enhanced CIP prototype through the:

- development of targeted decision support (offline and online) for sectoral decision making for climate change adaptation;
- provision of user training and support in ICIP and climate adaptation;
- further upgrading of the CIP prototype (Phase 3) in terms of QoE (aesthetic and responsiveness) and QoS (increased performance and enhanced security and back-up measures).

ICIP now stands as Ireland's primary national resource to support climate adaptation planning. The enhanced CIP offers adaptation practitioners a one-stop repository of useful and appropriate climate and adaptation information and knowledge. The ICIP outreach and capacity-building programmes and initiatives have been successful in developing a community of adaptation practice that provides the scope for more sophisticated knowledge and experience sharing.

6.2 Recommendations

Following the first and second phase of the ICIP project, the third phase has demonstrated the potential for employing a national CIP and associated training and outreach activities to support policy-guided adaptation planning in Ireland, particularly at local and sectoral levels. Nonetheless, to further develop and increase the uptake of ICIP, and with the specific purpose of supporting integrated decision making for adaptation across all levels of governance, recommendations are made in a number of key areas:

- Adaptation is a new and evolving area of decision making for spatial and sectoral planners in Ireland. As a result, available decision-making supports (decision-making frameworks, tools and guidance) will need to evolve in line with the requirements of decision makers as they progress through the key stages of adaptation decision making, from

preparing the ground to implementation, and as their understanding of the scope and nature of the risks and vulnerabilities and the adaptation required progress.

- ICIP is a boundary resource, working at the science–policy interface, and considering the needs of stakeholders forms a critical component of development. As a result, to ensure that the CIP prototype continues to meet the needs of the user communities, it is essential that a partnership approach is adopted during the continued development of ICIP. This will ensure that information and tools delivered through ICIP are scientifically credible and of direct relevance to users and their decision-making contexts.
- Capacity building to allow for effective climate change action has been significantly enhanced through ICIP Phase 3 developments, e.g. through the delivery of ICIP's regional local authority adaptation training workshops and through the development of two sectoral adaptation plans. The effectiveness of these activities in increasing the uptake of ICIP is evidenced in increased user traffic to the CIP prototype. As a result, in order to further develop the market for adaptation and ICIP, there is a continued requirement to increase capacities amongst spatial and sectoral planners to employ ICIP in the initiation, development and delivery of adaptation plans.

Through three phases of development, ICIP has been funded on a project basis. To ensure the continued update and development of the CIP prototype by stakeholder groups, a strategic roadmap is required to sustain this key infrastructure and this should be underpinned by policy-supported mechanisms for funding.

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Abbreviations

CIP	Climate information platform
DAFM	Department of Agriculture, Food and the Marine
DCCAE	Department of Communications, Climate Action and Environment
DTTAS	Department of Transport, Tourism and Sport
EMRA	Eastern and Midlands Regional Assembly
ESGF	Earth Systems Grid Federation
EU	European Union
GHG	Greenhouse gas
ICHEC	Irish Centre for High-End Computing
ICIP	Ireland's Climate Information Platform
NAF	National Adaptation Framework
NCCAF	National Climate Change Adaptation Framework
NWRA	Northern and Western Regional Assembly
PT	Planning Team
QoE	Quality of experience
QoS	Quality of service
SAT	Sectoral Adaptation Team
SWRA	South and West Regional Assembly
UCC	University College Cork

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL
Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú
Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola *(m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola)*;
- gníomhaíochtaí tionsclaíocha ar scála mór *(m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta)*;
- an diantalmhaíocht *(m.sh. muca, éanlaith)*;
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe *(OGM)*;
- foinsí radaíochta ianúcháin *(m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha)*;
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil
- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce
- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol
- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil *(m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí)*.

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn
- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn.

Taighde agus Forbairt Comhshaoil
- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta
- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn *(m.sh. mórphleananna forbartha)*.

Cosaint Raideolaíoch
- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas
- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol *(m.sh. Timpeall an Tí, léarscáileanna radóin)*.
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta
- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil
Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:
- An Oifig um Inmharthanacht Comhshaoil
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Fianaise is Measúnú
- Oifig um Chosaint Radaíochta agus Monatóireachta Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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The Development of an Irish Climate Information Platform (ICIP) - Phase 3 (2015-2017)

Authors: Barry O'Dwyer, Mohammad Hashemi and Jeremy Gault

Identifying Pressures

Ireland's climate is changing in line with global trends and projections indicate that this trend will continue and intensify into the future. These changes and associated impacts will have a wide range of consequences for Ireland's economy, environment and society. As a result of past and present emissions of greenhouse gases (GHGs), we are now committed to climate change for many decades to come, regardless of ongoing mitigation efforts to limit GHG emissions. Therefore, to prevent or minimise the adverse impacts of climate change, planned adaptation to these changes is urgently required. As adaptation policy progresses, it is increasingly important that decision makers have access to relevant and high-quality information that can be used to support the development of national and transnational adaptation strategies and plans. In response, and adopting a phased approach to development, the EPA-funded project, Ireland's Climate Information Platform (ICIP), has developed a climate information platform (CIP) prototype for Ireland (http://www.climateireland.ie). This aims to provide decision makers with a one-stop web-based resource of climate and adaptation information for Ireland and support to build national capacity for adaptation.

Informing Policy

Through a partnership approach, ICIP Phase 3 (2015–2017) developed user-centred adaptation guidelines for sectoral decision making, which are underpinned by resources and tools made available through the CIP prototype. ICIP Phase 3 also increased users' capacity to apply the CIP prototype in adaptation planning through the provision of user-focused training. Through the enhancement of the existing CIP prototype and the continued promotion of ICIP as Ireland's key support for climate adaptation planning, ICIP Phase 3 increased the usage of this key online resource by local authorities and government departments.

Developing Solutions

ICIP Phase 3 has made substantial progress in developing a CIP tailored to the needs of adaptation decision making in Ireland and has demonstrated the potential for employing existing information and data in meeting the challenge of initiating, planning for and managing climate change adaptation. ICIP Phase 3 has further developed the CIP prototype to support planning for climate change adaptation at sectoral levels and increased capacity for adaptation planning at national and local levels. As such, in addition to containing user-defined information on the projected impacts of climate change at a range of scales, it also provides guidance, tools and support for developing adaptation strategies.

EPA Research: McCumiskey House, Richiew, Clonskeagh, Dublin 14.

Phone: 01 268 0100
Twitter: @EPAResearchNews
Email: research@epa.ie