

The Development of an Irish Climate Information Platform (ICIP) – Phase 2 (2013–2015)

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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:

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- 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.

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**The Development of an Irish Climate Information
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EPA Research Report

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by

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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.

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Executive Summary

Introduction

Warming of the climate system is unequivocal and, since the 1950s, many of the observed changes have been unprecedented. Each of the past three decades has been successively warmer than any preceding decade since 1850. The period from 1983 to 2012 was probably the warmest 30-year period of the last 1400 years in the northern hemisphere. It is now considered that anthropogenic greenhouse gas emissions since the pre-industrial era, together with other anthropogenic drivers, are extremely likely to have been the dominant cause of warming since the mid-20th century. In order to reduce the impacts of climate change, two complimentary policies have been adopted: mitigation and adaptation. Mitigation actions aim to limit emissions of greenhouse gases and enhance carbon sinks. However, as a result of latencies in the response of the global climate system, even if contemporary actions to limit the causes of anthropogenic climate change are successful, many of the impacts of climate change will be “locked in” for many decades to come and are expected to continue and intensify. As a result, adaptation, which aims to enable society to better cope with, manage or adjust to changing climate conditions, 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.” Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness, especially with greater rates and magnitudes of climate change. As a result, and taking a longer term perspective, immediate and anticipatory adaptation is now required and will enhance future options and preparedness.

For Ireland, there now exists a large and growing body of work on observed and projected climate changes and impacts and it is considered that there is a robust knowledge to support the process of adaptation planning. However, on account of the

disparate nature of this information, 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’s (EPA’s) Climate Change Research Programme (2007–2013) identified the need for a national climate change information system for Ireland.

Ireland’s Climate Information Platform

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 in Ireland with a one-stop web-based resource of climate and adaptation information on Ireland. ICIP phase 1 (2010–2013) identified the best technical options for the design of a CIP, established agreements with data holders and determined the needs of the end user community in order to develop a CIP prototype. ICIP phase 2 (2013–2015) was awarded under the EPA Science, Research, Technology and Innovation for the Environment (STRIVE) Programme in 2013 to build upon the existing CIP prototype and improve its usability and expand 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 platform and developing tools to support decision making for climate adaptation. This has been achieved using a partnership approach with stakeholders and at the end of the project an enhanced CIP prototype was delivered. In addition, ICIP phase 2 has explored options for operationalising the CIP prototype.

- The ICIP phase 1 prototype implementation was based on the Browser/Server architecture and has been managed by Clojure and was based on a Java Virtual Machine environment. As a result, there was no web server to support the deployment of the CIP prototype with implications for system tuning, optimisation and monitoring.

- In addition, given the relatively large amount of climate data being stored, there was the potential issue that the R programming language and Clojure scripts might not provide satisfactory system performance under a high request load. To overcome these issues, ICIP phase 2 development involved the redevelopment and deployment of the system architecture. The system architecture is now based on Java and the CIP prototype is now deployed using a Java web server, i.e. Tomcat, providing for the deployment of an enhanced and more dynamic interface and more sophisticated decision support tools.
- In order to improve the overall aesthetic of the CIP prototype and to enhance the usability of the CIP prototype, an ICIP phase 2 user group was established to guide development. On the basis of recommendations from the ICIP phase 2 user group, a number of enhancements were made through ICIP phase 2 development:
 - The look and feel of the CIP prototype has been enhanced to provide a more user-friendly, accessible and dynamic resource.
 - Navigation aids and feedback mechanisms have been incorporated into the CIP prototype to allow users to easily find their location within the CIP prototype and to quickly and easily provide feedback to the ICIP development team.
 - The presentation of information has been improved and updated. In order to support users in becoming quickly acquainted with the information contained on the CIP prototype, key information panels have been implemented on all pages of the CIP prototype. In addition, information on the CIP prototype has been updated in accordance with advances in climate and adaptation science, e.g. the Fifth Assessment Report of the IPCC.
 - In order to improve the credibility of the CIP prototype and to support users in accessing the underlying information and data, a dedicated database of onsite references has been developed and deployed, which allows users to quickly access a wealth of information on references employed in the CIP prototype including source information, all bibliographic information and abstracts where available.
 - ICIP's prototype *Climate Information Tool* forms a key resource within the CIP prototype. In close consultation with the ICIP phase 2 user group, the prototype *Climate Information Tool* has been enhanced significantly in terms of its look and feel, the inclusion of observed climate information and advanced data options.
 - The look and feel of the prototype has been improved significantly and has involved the incorporation of OpenStreetMap, which adds a wide range of functionality, e.g. users can now zoom in and out on their area of interest and query individual data points.
 - In order to support users in understanding their current climate conditions, the prototype *Climate Information Tool* now provides users with access to observed climate information for Ireland.
 - The functionality of the prototype *Climate Information Tool* has been improved significantly, offering users two levels of climate information. Users can now query available climate information according to ensembles of projected climate information (according to low–medium and high emissions scenarios) and according to the outputs of individual climate model experiments. In addition, charting technologies have been employed to allow users to visualise the full range of models according to the selected scenario and with reference to projected changes in temperature and precipitation for the period and season of interest.
 - In order to support local authorities in developing their adaptation strategies and in accordance with the requirements of the National Climate Change Adaptation Framework (NCCAF) (2012), ICIP phase 2 developments have enhanced the CIP prototype through the development of the *Local Authority Adaptation Support Wizard*. This is specifically aimed at local authorities and aims to allow these users to take full advantage of and integrate the different sources of information made available through the CIP prototype in the development of their adaptation plans. The tool adopts a participatory approach and guides users through the adaptation planning process from identifying their area of planning to developing and implementing an adaptation plan. In order to help users in overcoming uncertainties in climate

projection data, the tool adopts a tiered approach to impact assessment whereby the delivery of climate information is staggered and tailored to the decision-making context.

- On the basis of international experience, it is clear that project-based funding has provided ICIP with the opportunity to develop and demonstrate a functional CIP prototype. In order to further develop and operationalise the prototype, it is essential that a strategic plan that outlines current direction, scope and proposed development, in both the short and long term, is developed. Such a plan can then be used to effectively modify available capabilities and resources, as well as to communicate and engage users, contributors and collaborators. As a result, there is a requirement to establish a more long-term and strategic direction through policy-supported and/or mandated funding mechanisms. This funding must account for a range of ongoing and future resource considerations, which include housing of the system, future proofing, platform integrity and outreach and training.

Conclusions and Recommendations

ICIP phase 1 made substantial progress in developing a CIP that is 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. In addition, ICIP phase 1 demonstrated the potential of the ICIP project to act as a boundary organisation, bridging the science–policy interface and making the information required for adaptation decision making available, relevant and usable by decision makers. ICIP phase 2 has further developed the CIP prototype by enhancing the system architecture, improving the usability of the prototype and providing additional functionality and tools. This has been achieved in close consultation with project stakeholders and end users. Nonetheless, in order

to operationalise the prototype and to effectively address decision-making requirements under the NCCAF (2012), the Climate Action and Low Carbon Development Bill (2015) and the forthcoming National Adaptation Framework (NAF) (expected 2017), further development is recommended in a number of key areas:

- ICIP phase 2 development was specifically targeted at helping local authorities in the development of their adaptation strategies. In order to further develop and operationalise ICIP and to facilitate horizontal and vertical integration of adaptation across all policy areas and levels of governance, the requirements of sectoral decision making must now be considered. In addition, as climate and adaptation science progresses and as the needs of existing and new stakeholders evolve as they progress through the adaptation policy cycle, it is essential that ICIP remains current (i.e. is updated based on the evolving science, data and practice) and continues to meet the changing needs of existing and new users.
- User engagement and training has formed a key focus of ICIP phase 2 development. In order to ensure continued development and uptake of the CIP prototype, this engagement needs to be strengthened further and user support and guidance should form a key focus of the further development of ICIP.
- The CIP prototype has significant data-housing and handling requirements and this is expected to increase in the future as the climate and adaptation knowledge base evolves. As a result, it is recommended that the CIP prototype is deployed using a dedicated service provider.
- In order to ensure the continued development and update of the CIP prototype, a strategic roadmap for development is required. This roadmap should outline the transfer of ICIP from its current project-based funding mechanism to a policy-supported funding mechanism.

1 Introduction

1.1 Climate Change

The global climate is changing: the impacts of these changes are already evident and are expected to continue and intensify in the future (IPCC, 2013). For Ireland, observed changes in climate are in line with global trends and Ireland's climate is projected to change significantly in the coming decades (Gleeson *et al.*, 2013; Nolan, 2015).

In Ireland, annual average temperatures increased by 0.8°C over the period 1800–2012 (Dwyer, 2013). Projections indicate that this warming is expected to continue and increase by ~1.7°C by mid-century (Nolan, 2015). For precipitation, observations indicate that average levels of national rainfall have increased by approximately 60 mm (5%) for the period 1981–2010 when compared with the period 1961–1990. In contrast, projections of annual, spring and summer average precipitation suggest an overall reduction by mid-century (Nolan, 2015). For winter and autumn, projections indicate a notable increase in the overall frequency of heavy precipitation events (Nolan, 2015). Projections of precipitation, however, are subject to a relatively high level of uncertainty and should be viewed with a low level of confidence. Satellite observations indicate that sea levels in the marine areas around Ireland are rising about 3.5 cm per decade, with the greatest increases observed for the Irish Sea (EEA, 2014a). This is as a result of a more pronounced warming of the Irish Sea due to thermal expansion. Measurements obtained from a tide gauge situated at Newlyn in Cornwall, which reflects the situation to the south of Ireland, confirm this trend, indicating a mean sea level rise of ~1.7 mm for the period 1916–2012. Sea levels are projected to continue to rise by up to 0.81 m by the end of the century (IPCC, 2013).

Globally, climate change will have wide-ranging effects on all aspects of the environment, economy and society (IPCC, 2014). For Ireland, changes in rainfall patterns are likely to lead to an increased risk of flooding and water shortages (Bastola *et al.*, 2012; Hall *et al.*, 2013). Increasing temperatures will result in shifts in the growing season (Donnelly and O'Neill, 2013) and changes in the distribution of agricultural

crops and disease vectors (Holden *et al.*, 2008).

Projected temperature increases could have severe implications for habitats and species, with profound effects on our ability to conserve species and the habitats on which they depend (Coll *et al.*, 2012). Increasing sea levels will result in increased coastal inundation and erosion when combined with potential increases in levels of storminess and the increased risk of storm surge (Flood and Sweeney, 2012). Furthermore, climate change is expected to result in the increased occurrence of extreme weather events with potentially devastating consequences (IPCC, 2013). In contrast, climate change will also offer opportunities for Ireland's key economic sectors. For example, increasing temperatures and drier summers are likely to prolong the duration of the present peak tourism season into the shoulder months of April and September/October and allow for a diversification of tourism activities, including the development of outdoor activities and the expansion of nature-based activities (Kelly and Stack, 2009; Salmon, 2010). In addition, increasing temperatures and atmospheric concentrations of carbon dioxide may result in increased autumn and spring grass yields, which will allow livestock farms to increase their profits (Teagasc, 2010). It is also likely that the adverse impacts of climate change experienced elsewhere may create new market opportunities for Irish agriculture (RIA, 2003).

1.2 Climate Action

As of COP21 (Paris 2015), climate change is now recognised as a global challenge that requires policy responses in terms of both mitigating the causes of climate change and adapting to the now inevitable consequences of these changes (Figure 1.1). 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. However, as a result of latencies in the response of the climate system, even if contemporary actions

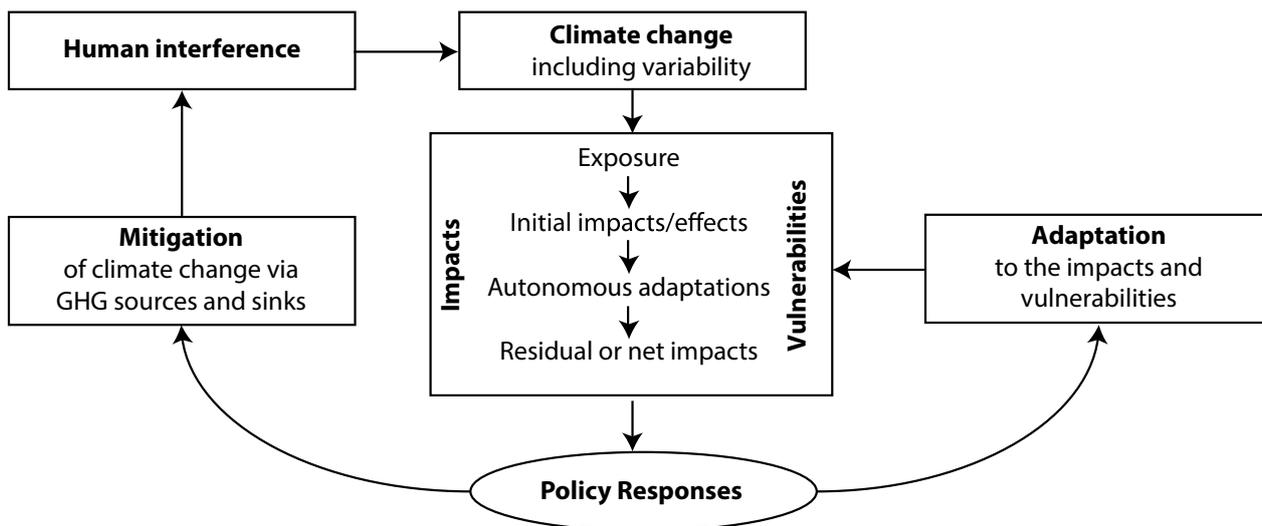


Figure 1.1. Summary diagram illustrating policy responses (mitigation and adaptation) to climate change.

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 until at least mid-century. 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, 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. Currently, 21 European Environment Agency member countries have developed a National Adaptation Strategy (EEA, 2014b), including Ireland, through the first National Climate Change Adaptation Framework (NCCAF) (DECLG, 2012), and 12 have developed a national adaptation plan (NAP). In Ireland, the first NCCAF (2012) provides a strategic policy response to ensure that adaptation measures are taken across all sectors and levels of governance to reduce Ireland’s vulnerability to climate change. More specifically, under the NCCAF (DECLG, 2012), the relevant government departments, state agencies and

all local authorities were provided with the mandate to commence the preparation of sectoral and local adaptation plans. This has resulted from the realisation that the adaptation challenge cuts across key economic sectors and, consequently, a wide range of policy areas. As a consequence, adaptation issues and priorities must be integrated across the full breadth of economic and development decision making. This is important because local differences in physical environment, land use and demographics mean that the task of implementing adaptation is principally the concern of regional and local-scale administrators, businesses and populations. More recently, this commitment is further reflected by the Climate Action and Low Carbon Development Bill (DECLG, 2015), which provides the strategic context for Ireland’s national response to climate change (mitigation and adaptation). More specifically, the bill calls for the development of the National Adaptation Framework (NAF). The NAF must be completed and submitted to the government by December 2017. The NAF will be a strategy for implementing adaptation measures across different government sectors and local authorities. The NCCAF includes the development of national and local level plans aimed at increasing Ireland’s adaptation capabilities (DECLG, 2012).

1.3 Delivering Adaptation Responses

Until recently, decision makers in Ireland tended to rely on past climate records to plan for the future. In the context of planning for a future, however, that includes

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 on the effects 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, including where and when these may occur and how different elements of the social, environmental and economic communities might respond.

The adaptation policy cycle (Figure 1.2) 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 and, following from this, an examination of adaptation options. The next step is to implement the adaptation option and the final step is to monitor and evaluate the action. Once this first iteration is complete, the cycle can begin again with a reassessment of vulnerability and risks. The steps in the cycle can then be reconsidered periodically in order to ensure that adaptation decisions are based on the most up-to-date data, 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).

1.4 Climate Information Platforms

As adaptation policy progresses in Europe, it is increasingly important that decision makers have

access to relevant and high-quality information. That requires information and evidence 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, 2013). Web-based platforms are considered an important tool within that strategy and a vital means of sharing information, evidence and experience of players and 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. This information and data 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 duplication and 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. However, the adaptation platform landscape is dynamic and the nature of individual platforms varies depending on their history, policy context, remits, target audiences and resources. These differences reflect 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

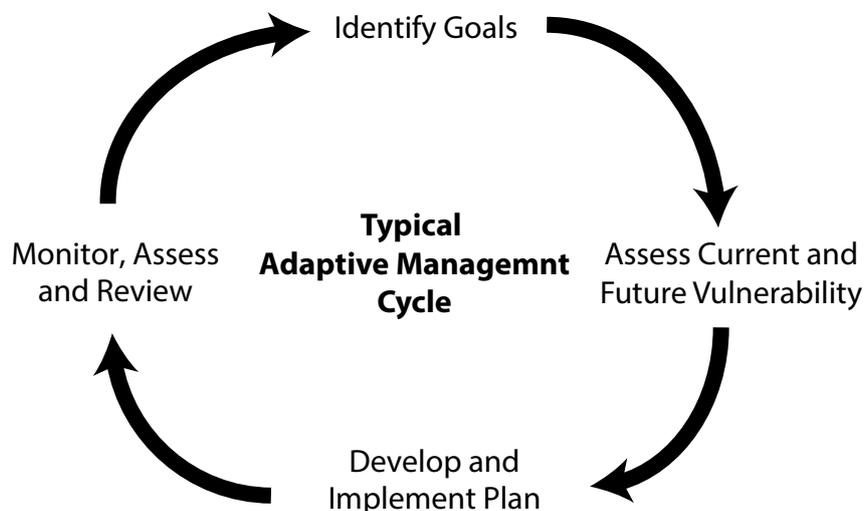


Figure 1.2. Schematic diagram of a typical adaptive management cycle.

by these web-based platforms varies, but it often includes policy actions at transnational, national and sub-national levels, scientific bases, research results, guidance, decision support tools and experiences from practice and implemented adaptation measures (case studies) (EEA, 2015).

1.5 Ireland’s Climate Information Platform

Ireland now has a significant amount of information on a wide range of climate variables, projections of future changes in these 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 by rising to the challenges posed by climate change with well-established approaches in developing mitigation strategies, as exemplified by the National Climate Change Strategy (2007) and the Climate Action and Low Carbon Development Act (2015). Policy in the area of adaptation has also been progressed through the publication of the National Climate Change Adaptation Framework (NCCAF) (2012) and more recently through the Climate Action and Low Carbon Development Act (2015) and the forthcoming NAF (expected 2017). 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 NCCAF, the relevant government departments, state agencies and local authorities are mandated to commence the preparation of sectoral and local adaptation plans.

In Ireland, currently, 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 complete, harmonised and easy-to-use data and tools with which to analyse them

are required. Hence, the 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 faces a number of institutional, technological, design and data challenges. 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 users’ opinions 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 of development of Ireland’s CIP (ICIP phase 1) has made substantial progress in addressing the challenges described above, providing a “one stop shop” resource of climate information and data for Ireland, and has the potential to serve as a key resource for communicating and supporting the analysis of climate impacts, vulnerability and adaptation options (www.climateireland.ie). Nonetheless, in order to operationalise the resource and support decision makers (national, local and sectoral) in fulfilling their obligations under the NCCAF (2012) and the forthcoming second NAF, further development was deemed necessary.

This report describes the second phase of development, which will build upon the existing CIP prototype, developed under ICIP phase 1, to produce an enhanced CIP prototype (ICIP phase 2) with the specific aim of supporting local-level decision makers in the assessment of climate change impacts, vulnerabilities and adaptation planning and in accordance with the requirements of the NCCAF (2012). In addition, this report identifies options for the operationalisation of ICIP.

2 Enhance the Usability of ICIP Phase 2

In order to improve the overall aesthetic of the prototype, stimulate engagement and interaction, and guide users' attention, an ICIP user group was established to guide ICIP phase 2 development. Members of this group include specialists in climate adaptation [Environmental Protection Agency (EPA) and University College Cork (UCC)], web development (EPA), user needs (UCC) and local authority representatives [(Clare County Council and South Dublin County Council (SDCC))]. Two dedicated user workshops were held, which had the specific aim of assessing the ease of use of the CIP prototype and the quality and relevance of information and data contained in the CIP prototype. On the basis of workshop findings, a number of key recommendations for improvements were identified for further development as part of ICIP phase 2.

Key recommendations on the ease of use of the CIP prototype:

- enhance the look and feel of the CIP prototype;
- include navigation aids and enhance feedback mechanisms.

Key recommendations on the quality and relevance of information and data contained in the CIP prototype:

- improve information provision and update information according to the latest updates in climatic and adaptation science;
- develop an improved referencing system;
- update and enhance the prototype *Climate Information Tool*.

2.1 Look and Feel

In order to enhance the usability of the ICIP phase 1 prototype and provide the basis for the deployment of an enhanced interface and more sophisticated decision support tools, improvement of the system architecture was required. The CIP phase 1 prototype was implemented by HTML for static web pages and Clojure programming language for the dynamic elements. Through ICIP phase 2 developments, the system architecture has been updated significantly and has included the integration of dynamic

elements through Java, HTML5 and jQuery. These enhancements have allowed for the development of a more user-friendly and accessible resource (Figure 2.1).

2.2 Navigation Aids and Feedback

Although users found the CIP prototype to be easy to use, clearly structured and well laid out, users cited the need for some navigation aids to help them in identifying their location within the prototype. In addition, users cited the need for a more obvious means of providing feedback to the ICIP development team. In response and through ICIP phase 2 development, breadcrumb navigation – which allows users to easily find their location within the CIP prototype – and search functionality have been implemented. A feedback button (linking to a feedback form) was included in the ICIP phase 2 prototype to allow users to quickly and easily provide feedback to the ICIP development team (Figure 2.2).

2.3 Information Improvement and Update

The CIP prototype was considered to be information rich by users and, although the information was deemed to be of high quality, credible and for the most part easily understandable, users expressed the requirement for additional summary information to allow them to quickly access and understand the key points of interest. In response, key information panels have been added to all pages on the CIP prototype (Figure 2.3) and these provide a summary of information contained on the page, allowing users to become acquainted with the information without having to read through all the information contained on the page. Each key information panel provides a brief statement of the problem covered in the page, background information and main conclusions. In addition, key projected changes in the most relevant climatic variables are illustrated.

The climate and adaptation knowledge base is constantly evolving and, in order to ensure that ICIP remains both credible and salient to users, it

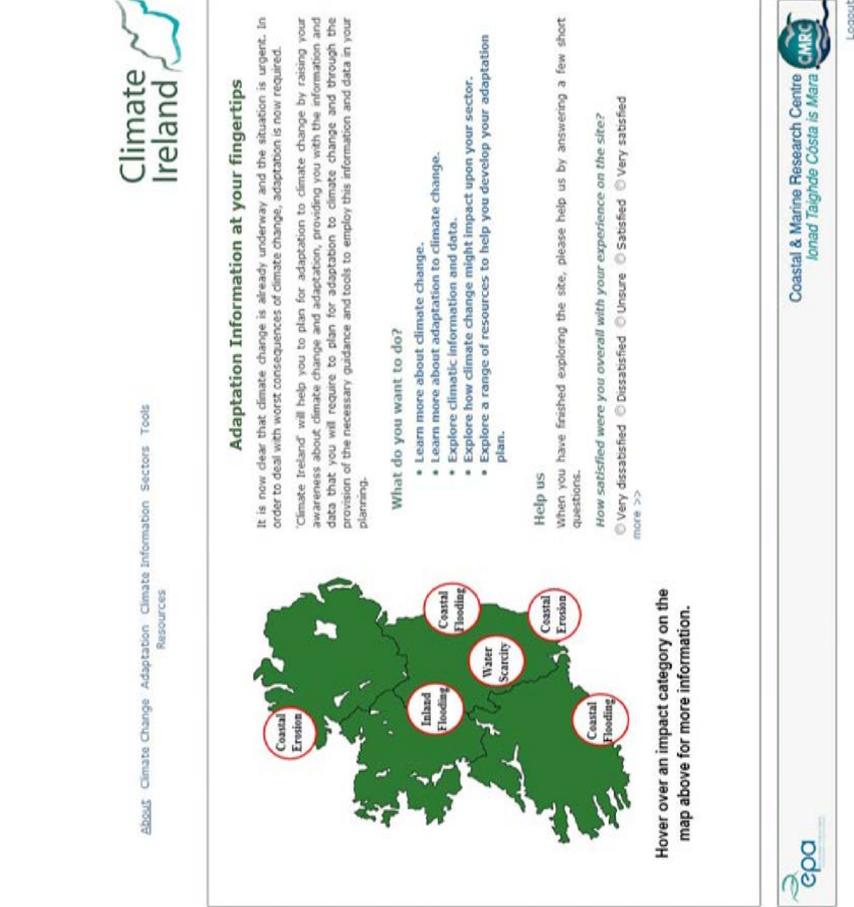
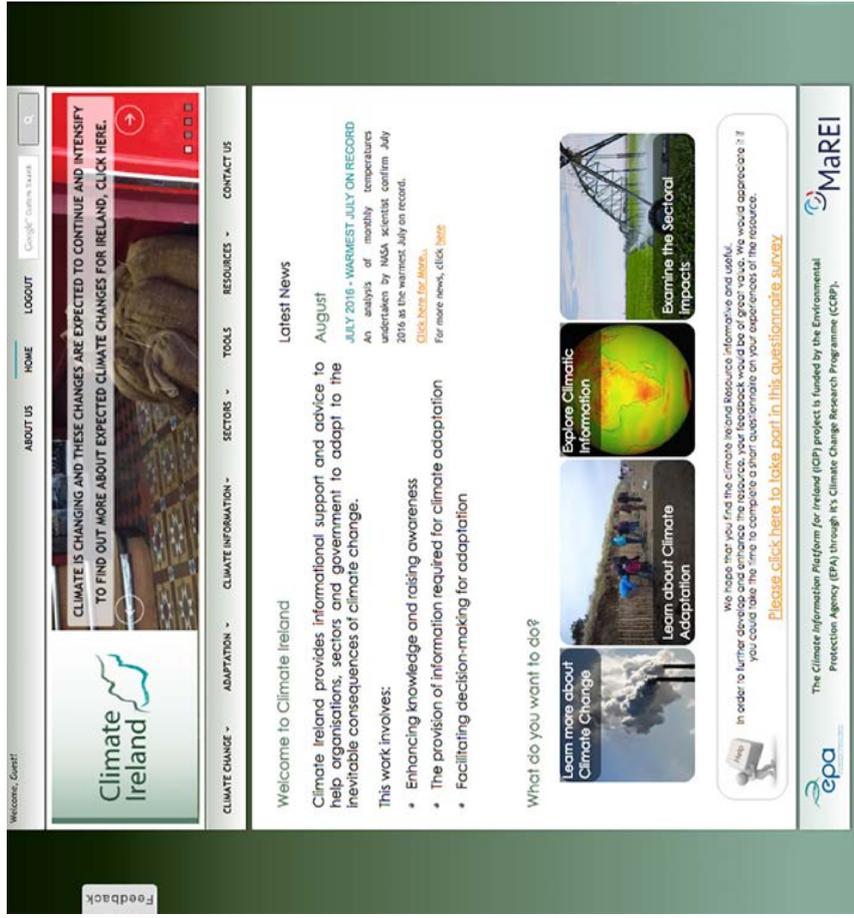


Figure 2.1. Screenshot of the ICIP phase 1 prototype (left) and the enhanced ICIP phase 2 prototype (right).

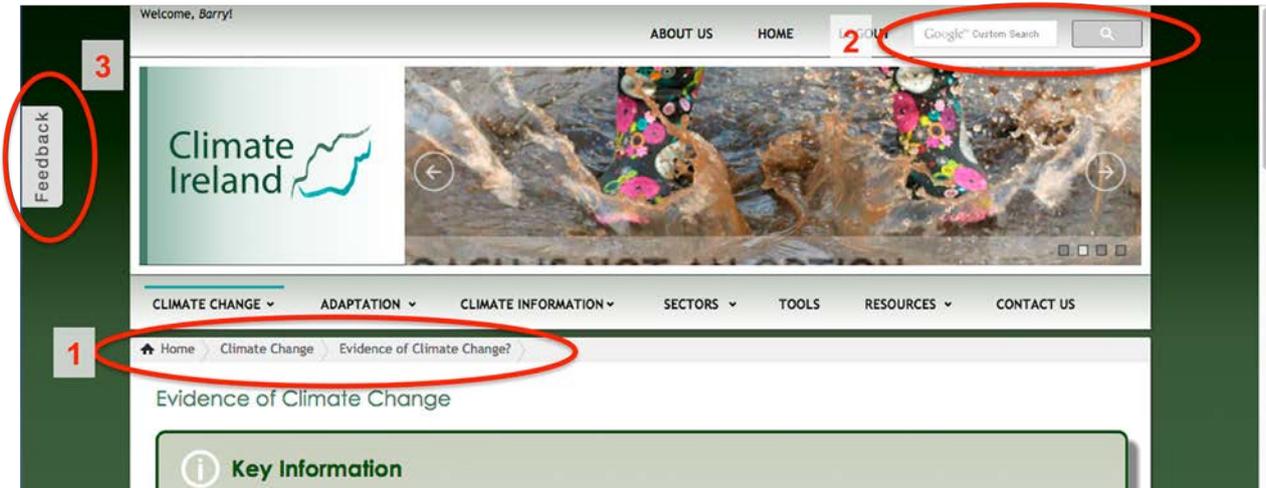


Figure 2.2. Screenshot of navigation aids implemented in Climate Ireland. (1) Breadcrumb; (2) search; (3) feedback.

Agriculture

i Key Information

- All aspects of Irish agriculture will be affected by climate change, the main impacts will result from **increased levels of atmospheric CO₂, changes in air and soil temperatures, changes in rainfall patterns and extreme events.**
- Globally, atmospheric concentrations of CO₂ are projected to increase and this increase is expected to **improve the net biomass production of agricultural crops.**
- Projected increases in temperature are expected to **increase the duration of the growing season** with spring occurring earlier. In addition, increased temperatures may result in **increased autumn and summer grass yields.**
- Wetter winters are likely for most parts of the country and this may result in **difficulties in accessing land with heavy machinery** having implications for, amongst others, the timing of planting, harvesting and fertiliser application.
- In contrast, Summers are projected to be drier and this may result in **increased water stress** for crops and an **increased irrigation requirement.**
- An increased frequency of heat waves and drought is projected and this may result in the **increased occurrence of heat stress for both plants and animals.** In contrast, the occurrence of cold snaps and frost days is expected to decrease and this will have implications for pest die-off and plant health.
- Projected shifts in climate, temperature and precipitation, may result in the **increased occurrence of plant diseases** which are currently rare and farm animals may suffer from a range of **tick-borne pathogens.**

 Level of atmospheric CO₂ are projected to increase markedly from current average levels (400 ppm) to 600 ppm by 2100.

 Spring is expected to occur earlier, extending the length of the growing season.

 Average temperature changes of 1 - 3 °C by 2100.

 Increases in the occurrence of heatwaves and droughts is likely

 Wetter winters are likely and this may result in difficulties in accessing land.

Figure 2.3. Screenshot of an example of a key information panel developed for Climate Ireland.

is essential that information on the CIP prototype remains dynamic, up to date and confirms the validity of existing information contained in the CIP prototype. Through ICIP phase 2 development, information contained in the CIP prototype has been updated significantly and in accordance with developments in climate and adaptation science. For example, the publication of the IPCC AR5 report (2013) required site-wide updates (projected and observed), while the publication of Ireland’s Climate Action and Low Carbon Development Bill (2015) required the update of information on adaptation policy. In addition, the prototype’s news feed was updated regularly throughout ICIP phase 2 development ensuring that the prototype remained “live”.

2.4 Referencing

Although the production of climate- and adaptation-related knowledge has improved significantly, the use of this knowledge by policymakers and decision makers is dependent, to a large extent, on how the information is presented. As a result, ICIP aims to present information in a user-friendly way that addresses the needs of the various end users, making

it necessary to rewrite information from research reports or technical reports, avoiding scientific terms and using alternative means to present the information (e.g. visualisations). A key challenge, however, is to ensure not only that this information is accessible and easy to understand but also that it is credible.

In order to ensure the credibility of information provided, a referencing system has been developed through ICIP phase 2. This system allows for more efficient onsite referencing of information and provides users with comprehensive information on references employed in developing information contained in the CIP prototype. In addition, the system allows for a dynamic method of referencing whereby all in-text reference information is contained in a project database (Figure 2.4) and can be populated dynamically from this database where and when required (Figure 2.5). Importantly, these improvements allow users to quickly access a wealth of information on the references employed, including source information, all bibliographic information and abstracts where available. Currently, the reference database is accessible to the ICIP development team, but the system has been developed with the potential to open the database to all stakeholders when requested.

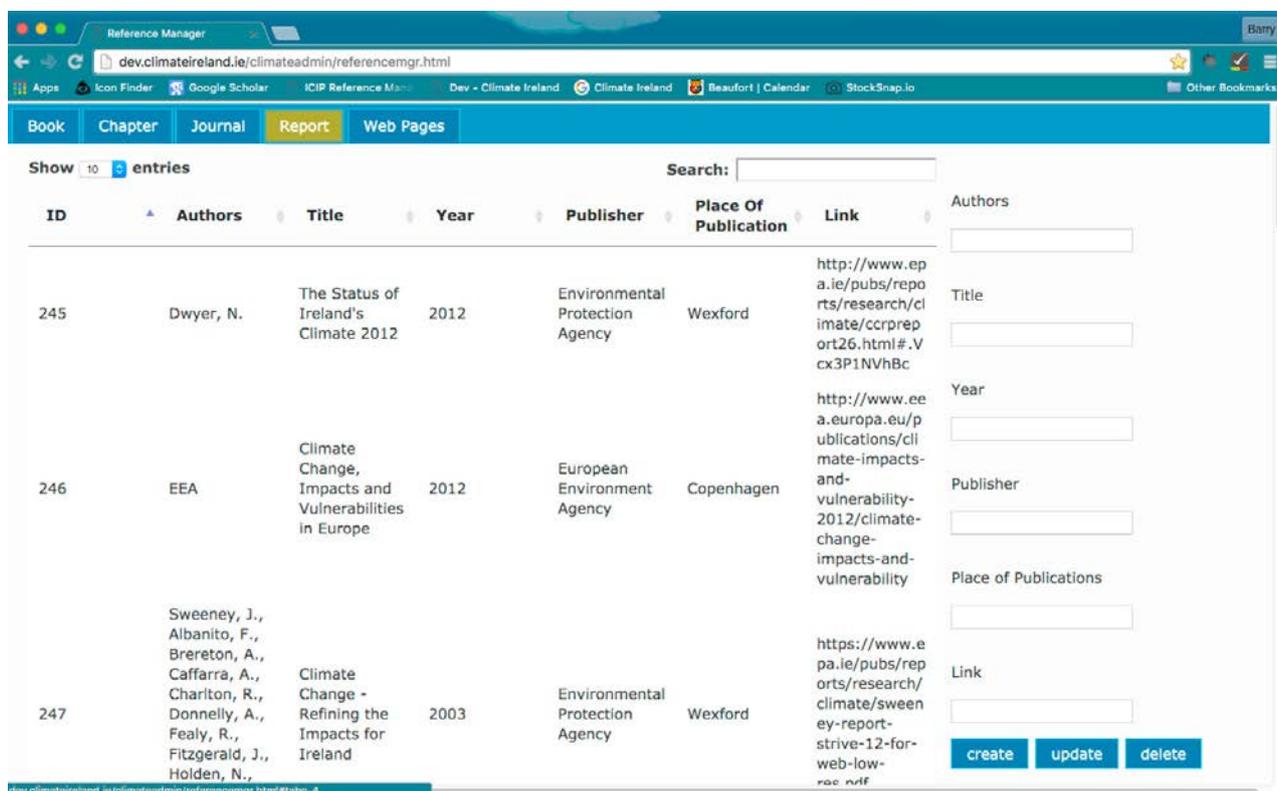


Figure 2.4. Screenshot of ICIP’s reference management system.

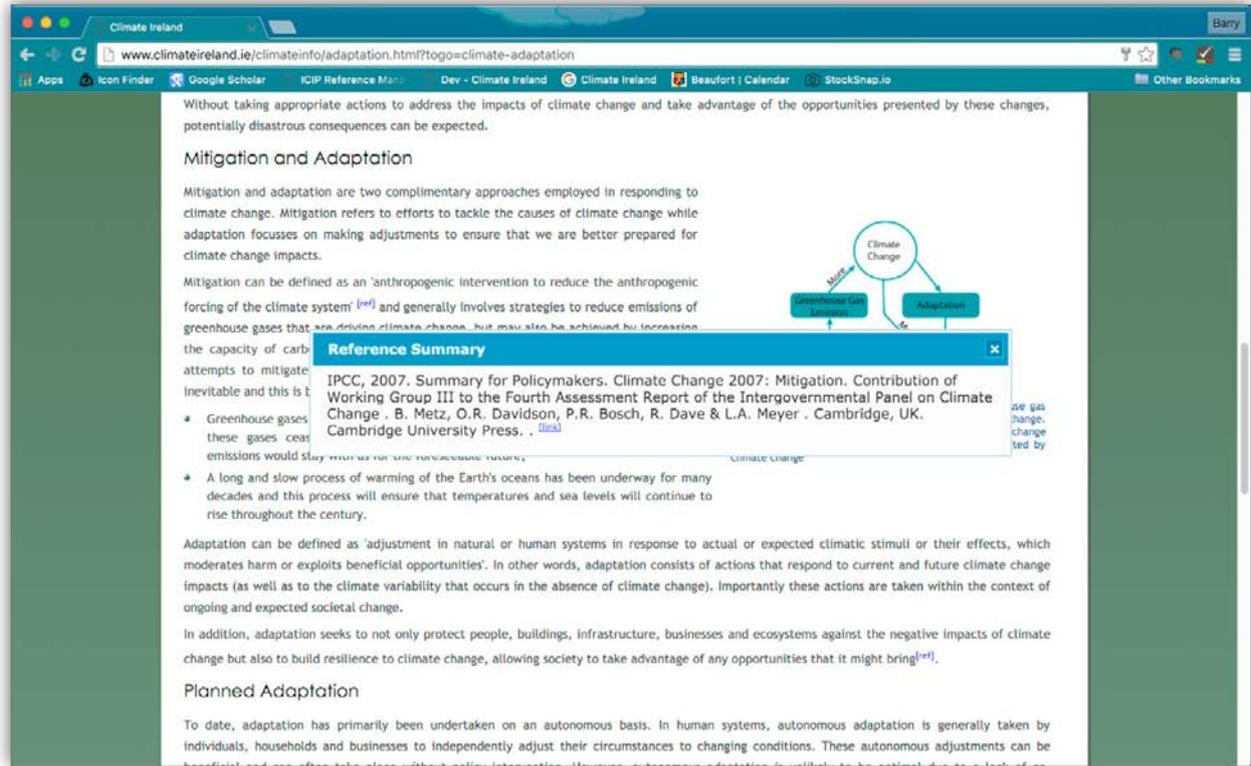


Figure 2.5. Screenshot of ICIP highlighting the referencing system in operation.

3 Prototype Climate Information Tool

The prototype *Climate Information Tool* forms a key resource within the CIP prototype. Through ICIP phase 2 development and in consultation with end users, ICIP’s *Climate Information Tool* has been upgraded substantially. Key improvements include: enhancement of the look and feel and functionality of the prototype *Climate Information Tool*, the inclusion of observed climate information and the development of tiered options for data selection and visualisation.

3.1 Updates to System Architecture and Look and Feel

Through ICIP phase 2 development, the overall look and feel and functionality has been upgraded significantly (Figure 3.1). The enhanced *Climate Information Tool* employs OpenStreetMap, which adds a wide range of functionality, e.g. users can now to zoom in and out of their area of interest and query individual points. In addition, the *Climate Information*

Tool can accommodate data loading through web services. For example, over the reporting period, access to Office of Public Works (OPW) data [e.g. Preliminary Flood Risk Assessment (PFRA)] has been obtained and these data can now be visualised through the *Climate Information Tool*.

3.2 Observed Climate Information

In order to help users in understanding what projected changes in key climate variables might mean for them, the prototype *Climate Information Tool* has been updated to include observed climate data for Ireland (Figure 3.2). This information is a prerequisite to understanding the implications of projected climate changes. This tool is based on data reported by Walsh (2012) and allows users to examine current climate conditions for Ireland (1981–2010) for a range of variables (average precipitation; average, maximum

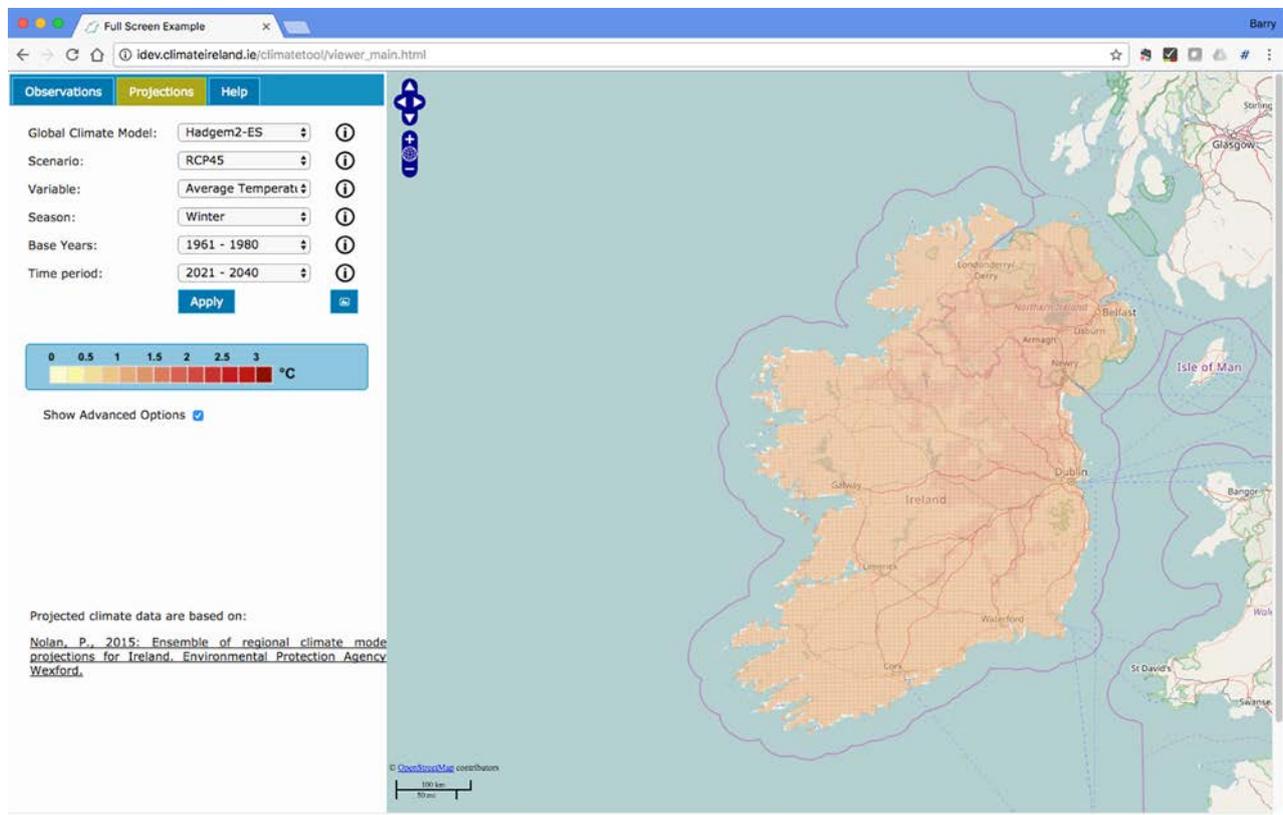


Figure 3.1. ICIP phase 2 *Climate Information Tool*.

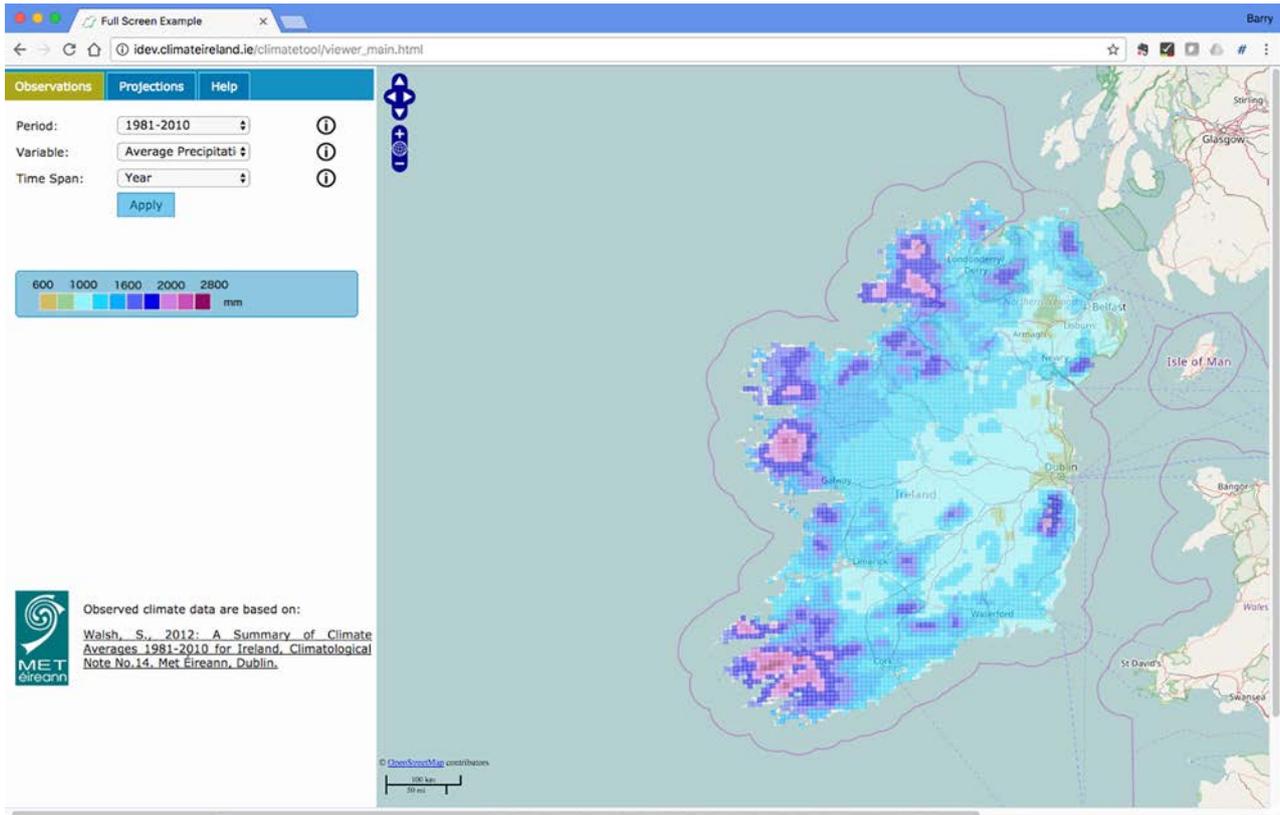


Figure 3.2. Screenshot of ICIP's *Climate Information Tool* displaying observed climatic norms for Ireland, based on data reported by Walsh (2012).

and minimum temperature) and for a range of time periods (annual, seasonal and monthly).

3.3 Advanced Options for Data Selection and Visualisation

Through ICIP phase 2 development, the functionality of the *Climate Information Tool* has been upgraded significantly (Figure 3.3). The tool now offers users two levels of climate information. Functionality has now been included to allow users to visualise ensemble values of projected climate data, calculated for low-medium and high scenarios of change, for a range of periods (2021–2040; 2041–2060; 2021–2060),

seasons (winter, spring, summer and autumn) and variables (average temperature and precipitation; maximum and minimum temperature). In addition, and for more advanced users, functionality has been developed to allow users to examine the outputs of individual climate model experiments according to future scenario, climate variable, season and period of both projection and reference. In addition, charting options are now included to allow users to visualise the full range of models according to the selected scenario and with reference to projected changes in temperature and precipitation for the period and season of interest.

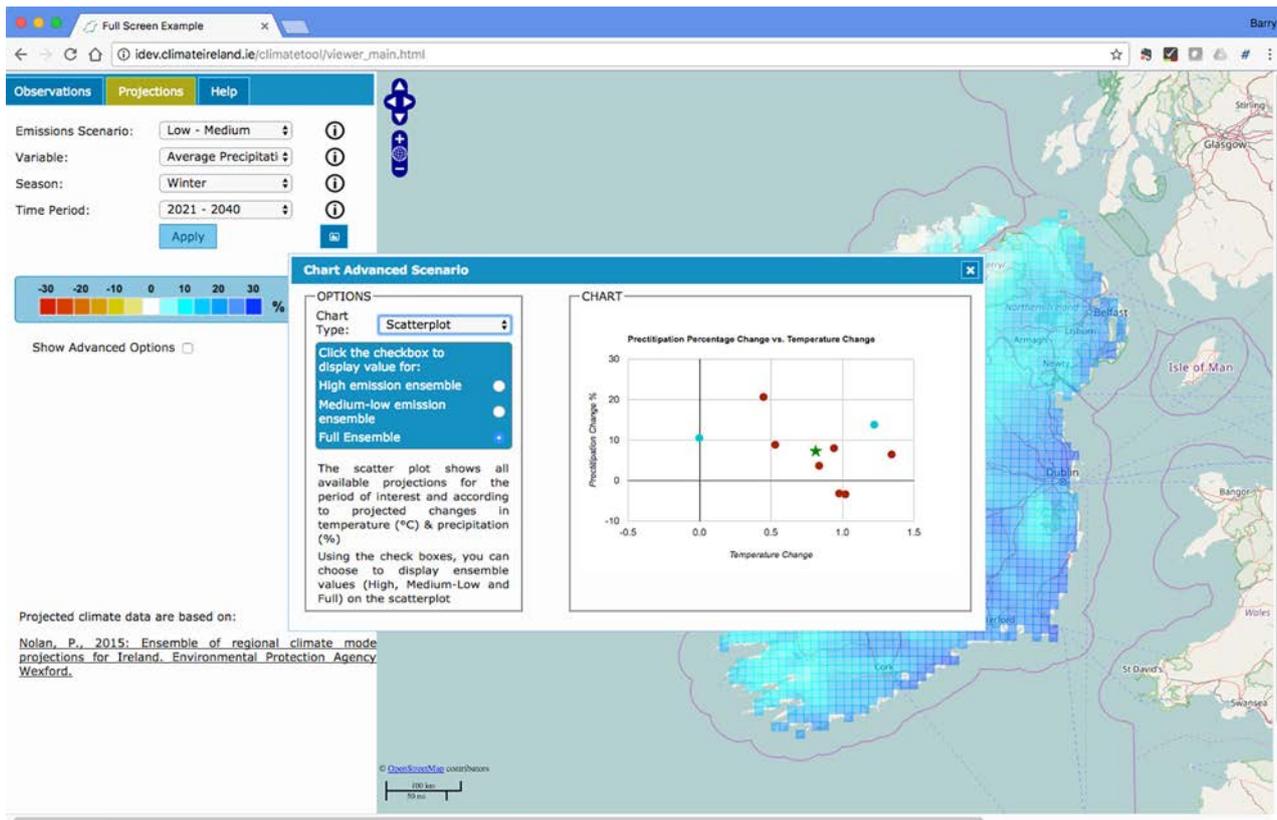


Figure 3.3. Screenshot of the *Climate Information Tool* with charting option activated, based on data reported by Nolan (2015).

4 Development of ICIP Local Authority Adaptation Support

Adapting to climate change is a highly complex undertaking for decision makers at all levels of government, but particularly for those at a local scale. While adaptation policy has been developed at the national scale (e.g. NCCAF, 2012), local differences in physical and environmental conditions, land use and population makes the task of implementing adaptation principally the concern of local scale administrators. In order to support local-level decision making for climate adaptation and in accordance with the requirements of the NCCAF (2012), ICIP phase 2 developments have enhanced the CIP prototype through the development of the *Local Authority Adaptation Support Wizard* (Figure 4.1)

ICIP's *Local Authority Adaptation Support Wizard* is specifically aimed at local authorities and aims to support local authorities in the development of their adaptation plans in accordance with the requirements

of the NCCAF (2012). Importantly, ICIP's *Local Authority Adaptation Support Wizard* aims to allow these users to take full advantage of and integrate the different sources of information made available through the CIP prototype in the development of their adaptation plans. Development of the tool was based on findings from consultation with the key user groups (e.g. SDCC), available and existing climate adaptation support tools [e.g. the United Kingdom Climate Impacts Programme (UKCIP) Adaptation Wizard and the EU Climate-ADAPT Adaptation Support Tool], and adaptation frameworks (e.g. Gray, 2015).

ICIP *Local Authority Adaptation Support Wizard* adopts a six-step approach in supporting users through the adaptation planning cycle by identifying their areas of planning and the key stakeholder groups involved in developing and implementing an adaptation plan. As detailed in Figure 4.2, for each step in the tool

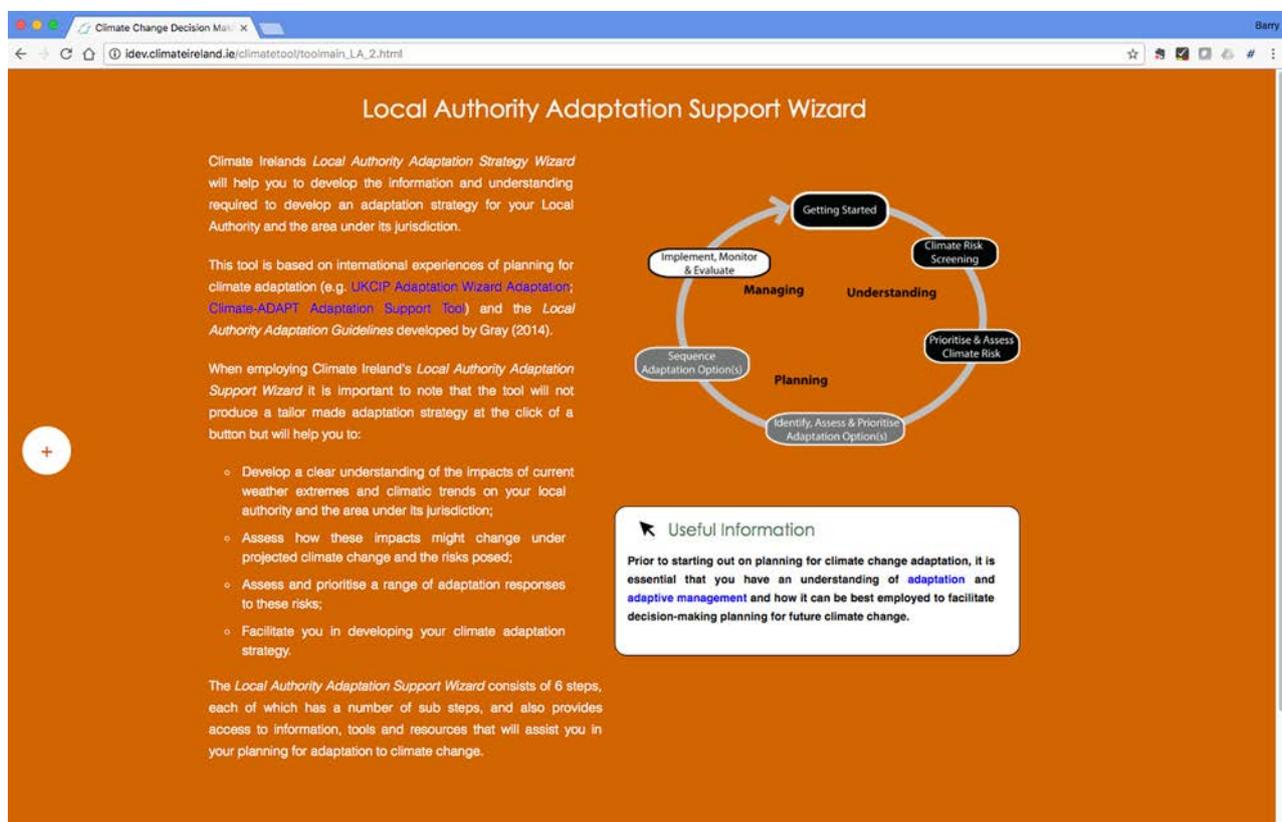


Figure 4.1. A screenshot of ICIP's *Local Authority Adaptation Support Wizard*.

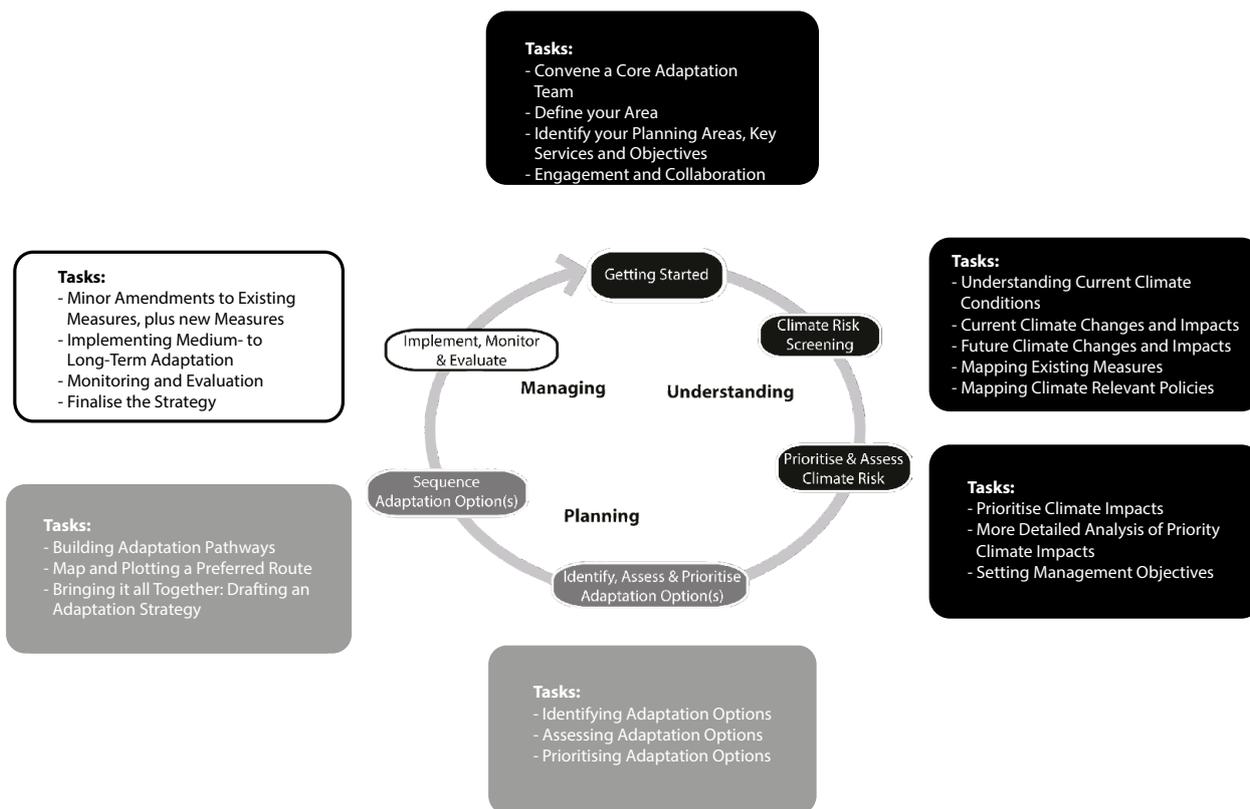


Figure 4.2. Schematic diagram of ICIP's *Local Authority Adaptation Support Wizard* six key steps; tasks are detailed.

there are a number of tasks. In addition, for each step in the tool a worksheet is provided to assist users in gathering the information required for each task. The tool adopts a participatory approach that functions as a means for stakeholder deliberation and engagement. As illustrated in Figure 4.3, in order to support users in overcoming the uncertainties in projected climate information, the tool adopts a tiered approach to risk assessment whereby the delivery of climate information is staggered and tailored to the requirements of the decision-making process (Ranger *et al.*, 2010). In contrast to the science-first approach to adaptation planning, where detailed climate projection information is a prerequisite to assessing vulnerability, users are encouraged to first develop their understanding of current climate conditions and to undertake a wide-ranging assessment of the known impacts of current and potential future climate changes on the area they manage. This is achieved through a sensitivity analysis, which involves a rapid vulnerability assessment that allows for an exploration of climate sensitivities with stakeholders – i.e. a learning-by-doing approach. By examining and discussing the importance and relevance of climate variables,

stakeholders can consider and prioritise climate impacts for further and more detailed analysis.

4.1 Getting Started

“Getting started” aims to prepare the ground for the development of a successful adaptation planning process. This step aims to first ensure that a core adaptation team is put in place, that senior management buy-in or support is obtained from the outset and that the scope of the adaptation strategy is identified.

4.1.1 Core adaptation team

In starting the development of an adaptation strategy and when employing ICIP's *Local Authority Adaptation Support Wizard*, it is essential that the adaptation team is fit for purpose and that the prerequisite skills are in place [e.g. expertise in geographic information systems (GISs), database development and analysis]. In addition, and at the outset, it is important to recognise that the development of the adaptation strategy will require a substantial resource

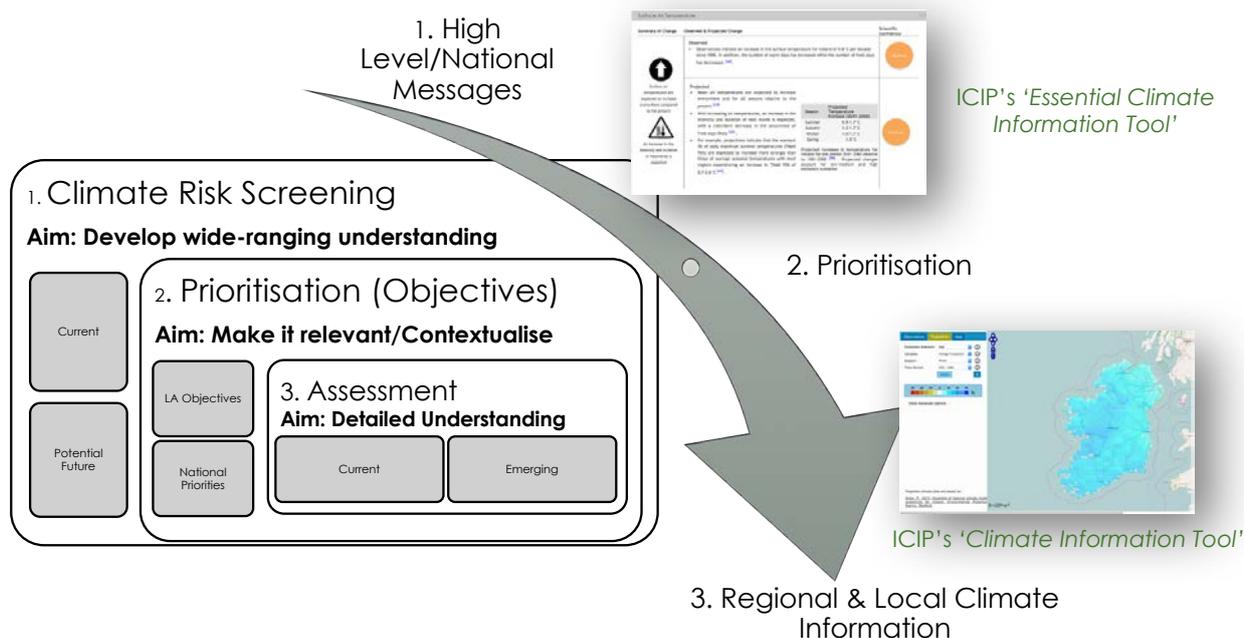


Figure 4.3. Tiered assessment of climate impacts and vulnerabilities. LA, local authority.

contribution in terms of both staff time and resource. As a result, senior management buy-in or support is essential to ensure that the required resources can be brought to bear both in the development of the adaptation strategy and in actions that may result from the adaptation strategy itself. In addition, it aims to ensure that a broad spectrum of knowledge and skills is brought to bear in the development of the adaptation strategy.

4.1.2 Define your area

The delineation of the area or community for which an adaptation plan is to be developed is an important first step in the adaptation planning process, as it allows for the determination of key resources or activities to be examined, the stakeholders to be included in the project team and the key audience for the results (Stocker *et al.*, 2012) (see Figure 4.4). In addition, it is also important to identify dependencies that are situated externally to the area or community under investigation, e.g. transport system dependencies.

4.1.3 Identify your key planning areas, services and objectives

Climate change will have wide-ranging impacts for local authorities, and developing an inventory of

planning areas, the key services that they provide and their objectives is of importance. This is because these planning areas, key services and objectives will serve as a focus for adaptation efforts and will facilitate the mainstreaming of climate change adaptation within existing plans, policies and programmes. For local authorities in Ireland:

- **Key planning areas** include housing and building, planning and development, roads and transport, water and sewerage, environmental protection and provision of recreational facilities.
- **Services** refer to those provided directly by the planning areas and include provision of council housing (housing and building), drainage and wastewater removal (water and sewage), and provision of safe footpaths, street lighting and flood protection (roads and transport).
- **Objectives** refer to those of each of the key planning areas. For example, for SDCC a key objective is to increase the tourism offering of the area (SDCC Tourism Strategy) and for the local authority overall corporate and economic plans and strategies are examples of key objectives.

4.1.4 Engagement and collaboration

Climate change will have wide-ranging and spatially differentiated effects, and adaptation can

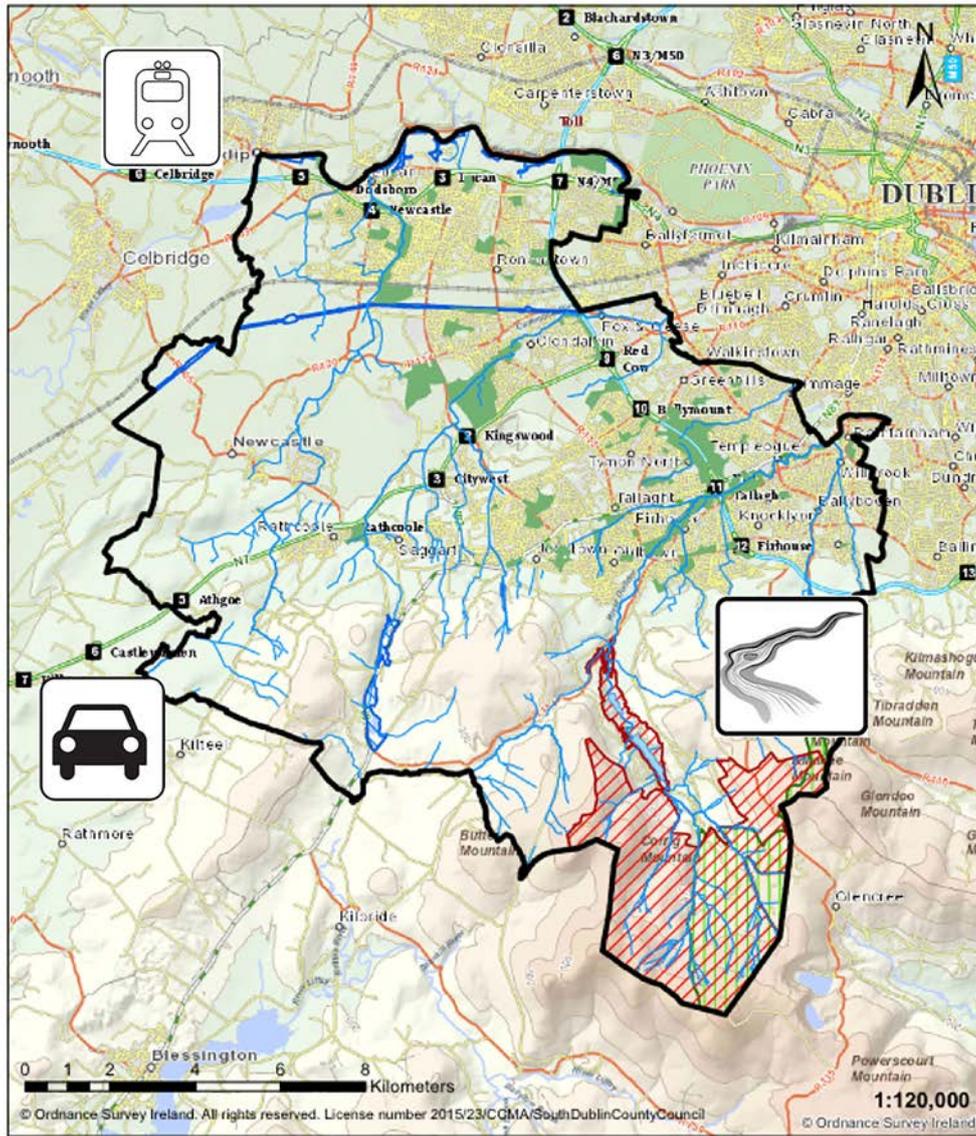


Figure 4.4. Map delineating boundaries of adaptation planning area for SDCC. Water Framework Directive (WFD) river and lake water bodies, SDCC parks, proposed National Heritage Areas (NHAs), Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and key interdependencies (e.g. road and rail) are also shown.

thus be considered highly contextualised, and no single approach to adaptation will work in different communities. As a result, the adaptation required will vary markedly between different areas and stakeholder groups and will sometimes require substantial changes

to local practices. These changes will have a better chance of success if they originated in a process that involves a high level of stakeholder engagement (see Table 4.1 for a list of stakeholders consulted as part of SDCC planning). The adaptation strategy development

Table 4.1. Stakeholder groups consulted as part of SDCC planning

Internal stakeholders and key issues consulted on	External stakeholders and key issues consulted on
Environmental protection and public realm (habitats, parks and green spaces, environmental quality, waste)	Department of Tourism, Transport and Sport (road and rail)
Roads and transport (roads and public lighting)	Irish Water (water treatment and supply)
Architects (building design)	NPWS (habitats, parks and green spaces)
Water (water supply and treatment)	Chamber of Commerce (economy)
Tourism (tourist offering)	
Housing (supply and maintenance)	

NPWS, National Parks and Wildlife Service.

process must therefore include a structured and substantive programme for the engagement of neighbouring local authorities, state sector bodies, relevant non-governmental organisations (NGOs) and stakeholders from within the local community.

4.2 Risk Screening

An essential step in understanding how current and projected climate changes might affect a local authority and the area under its jurisdiction is to first develop an understanding of current and local climate conditions and the factors that contribute to these. For example, regional climate can have its own qualifiers, and the topography of an area can greatly influence your local climate conditions through the rain shadow effect, among other things. Following from this, a high-level assessment of the impacts of current and potential future climate changes on the area of operation is undertaken. This step in the tool supports local authorities in gathering information on the full known range of climate impacts for their area and the potential consequences of these for local authority services and activities.

4.2.1 *Understanding current climate conditions*

In order to understand how climate change impacts might manifest themselves, a clear understanding of current climate conditions and changes to these is required. On this basis, employing information made available through ICIP's *Climate Information Tool* and Met Éireann's synoptic station network, this task supports the development of a local-level understanding of current climate conditions and changes to these (see Figure 4.5 for an example).

4.2.2 *Current climate changes and impacts*

In order to come to an understanding of the full known range of climate- and weather-related impacts for the specific area, this task supports local authorities in undertaking a preliminary assessment of climate- and weather-related impacts (see Table 4.2). This assessment is based primarily on stakeholder input and literature review and involves a high-level assessment of the impacts and vulnerabilities of current climate changes, including both gradual climate changes and extreme events (with reference to Met Éireann's database of extreme weather events). The assessment is undertaken according to both the impacts on the area under investigation (buildings and infrastructure, health and well-being, habitats, parks and green spaces) and the consequences for the delivery of services by the local authority. The key outputs comprise the full known range of climate- and weather-relevant impacts for the area under investigation.

4.2.3 *Potential future climate changes and impacts*

In order to come to an understanding of the full known range of potential future climate- and weather-related impacts, this task supports local authorities in undertaking a preliminary assessment of potential future climate- and weather-related impacts for their area. This assessment involves assessing how current climate impacts might increase or decrease under projected climate changes and whether or not there are any new or emerging impacts that need to be considered (Figure 4.6). The assessment is based primarily on stakeholder input and broad-scale/ national-level climate projection information provided through ICIP's *Essential Climate Information Tool* and

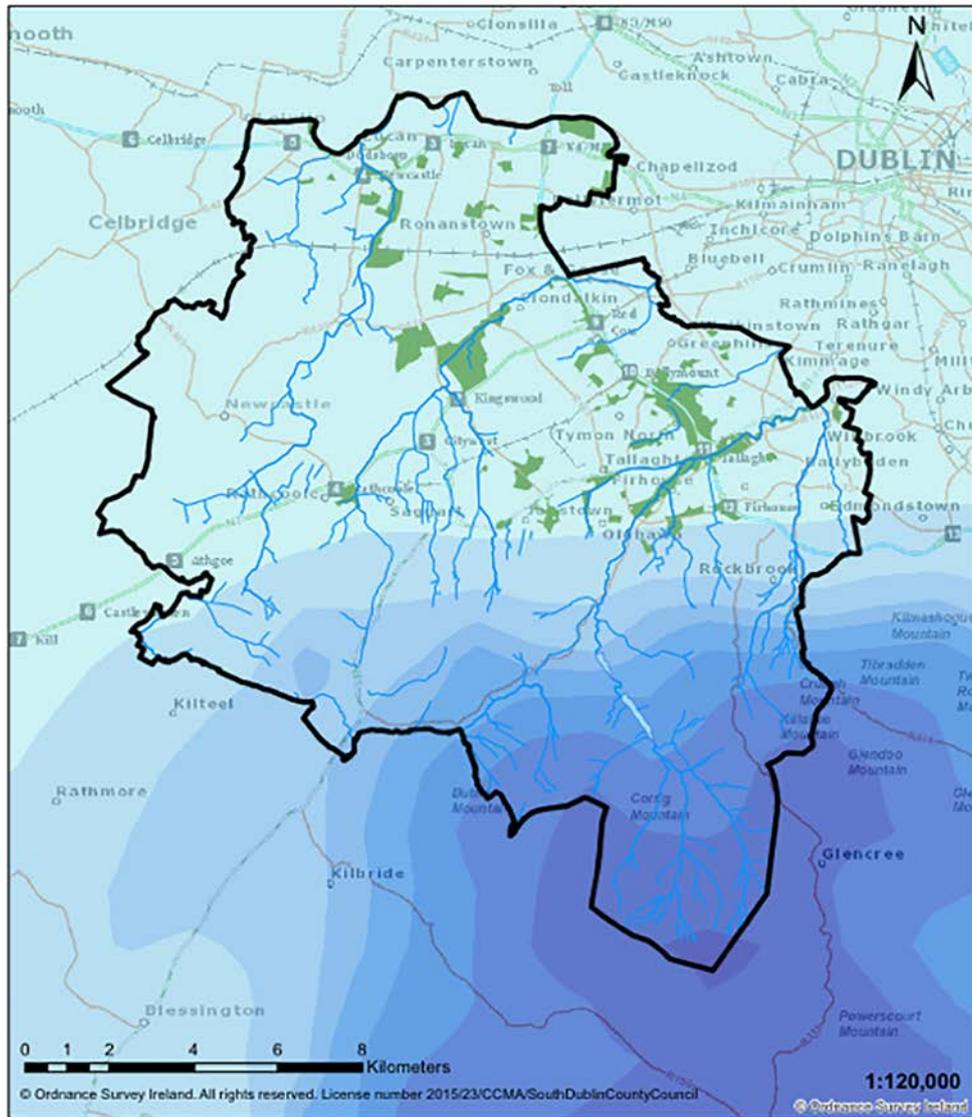


Figure 4.5. A map illustrating average levels of precipitation for SDCC, based on Walsh (2012). High levels of precipitation characterise areas to the south. This precipitation is then carried by rivers into and through SDCC. WFD, Water Framework Directive.

impacts provided through ICIP’s *Sectoral Adaptation Tool*.

4.2.4 Mapping existing measures

This task in the tool seeks to identify measures and/or plans already in place to counteract climate impacts

and to understand the estimated lifetime of these and any design limits that might apply to them. This information will provide a basis on which to assess the requirements for additional adaptation in the face of current climate- and weather-related impacts and projected changes in these.

Table 4.2. An example of an output for SDCC from Task 2.2 (Current Climate Changes and Impacts)

Climate change/ weather event	Impacts			Consequences
	Buildings and infrastructure	Health and well-being	Habitats, parks and green spaces	
Extreme rainfall e.g. 24 October 2011	95 social houses flood damaged (€1.2 million in housing insurance claims)	Two families required to find alternative accommodation	Poddle, Camac and Owendoher Rivers flooded with implications for river morphology	Staff required for pumping of water, clean-up and emergency response (co-ordination)
	Clearing of road gullies, screens on rivers and channels; clearing of roads of debris and liquid mud	Nursing home in Citywest evacuated to sister home in Swords Isolation of vulnerable communities	Parks and green spaces used as attenuation	Staff overtime, re-deployment (roads) and fatigue

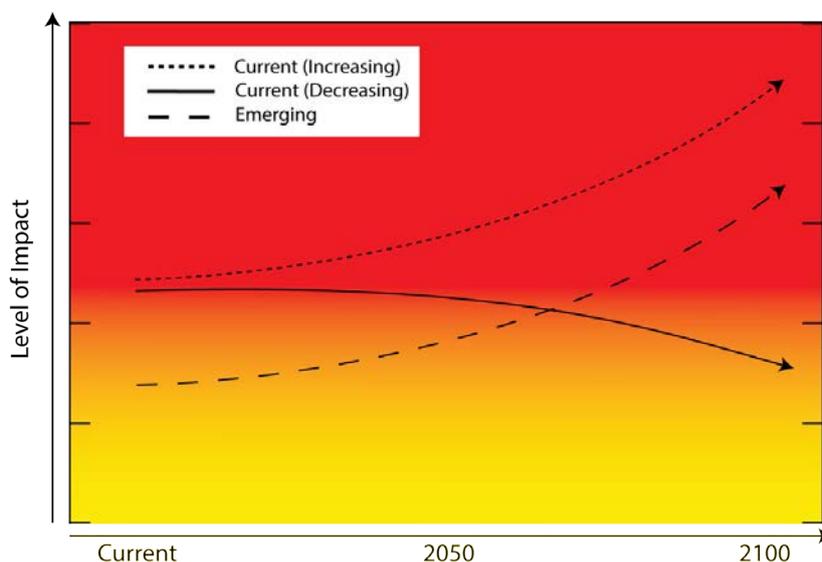


Figure 4.6. Conceptual framework for assessing how levels of climate- and weather-related impacts might change in the future. Both current and emerging impacts are assessed.

4.2.5 Mapping climate relevant policies

In the short term, the management of climate impacts must be undertaken within the context of existing management objectives and policy requirements. As a result, it is important to understand the policy landscape surrounding the management of current climate impacts. For example, extreme precipitation events have implications for the achievement of bathing water quality targets (Blue Flags) as a result of overland flow of pollutants into watercourses and coastal areas resulting in degradation of water quality. As part of this task and in collaboration with the local authority's adaptation team, the range of policies,

regulations and instruments that are of relevance in the management of these impacts is examined.

4.3 Prioritise and Assess Climate Risk

Following from the development of an understanding of the full known range of current and potential future climate impacts on the services and functioning of local authorities, this step supports users in prioritising climate impacts, provides a more detailed assessment of the impacts and consequences of identified priority climate impacts, and supports the establishment of management objectives in relation to climate risks.

4.3.1 Prioritise climate risks

The aim of this step in the tool is to identify those climate impacts that pose a sufficiently high risk to warrant further and more detailed analysis. Prioritisation of climate- and weather-related impacts is based on ongoing and potential future impacts (increasing/decreasing) on the services and activities of the local authority and existing policy and legislative requirements. For example, for SDCC, key priority risks included those from extreme weather events (wind storms and precipitation) due to ongoing impacts, while increasing temperatures were also considered a priority as a result of potential future implications for biodiversity (e.g. overwintering of pests and diseases) under projected temperature increases.

4.3.2 More detailed analysis of priority climate impacts

The aim of this task is to report on priority climate impacts in a descriptive and clearly presented way that is accessible to all stakeholders. This assessment will collate all relevant information (quantitative and qualitative) to prepare the groundwork for adaptation action. Information is collated and examined according to the following topics: recent experiences

of climate- and weather-related impacts; projected climate changes and potential impacts; description of potential consequences. This assessment draws on information provided through ICIP's *Climate Information Tool* and *Climate Hazard Scoping Tool*. Importantly, this task supports users in employing their understanding of current climate- and weather-related impacts as a guide to assessing potential future impacts and consequences (Figure 4.7). The focus on priority impacts aims to make the assessment more manageable (in terms of the time and resources available) and it should be noted that impacts and risk not currently considered as a priority are not dismissed and instead a watching brief on these is maintained.

4.3.3 Setting risk management objectives

Through step 2 (Task 2.4), relevant policy, legislation and strategies that guide the social, economic and environmental development of a local authority and the areas under its jurisdiction have been mapped. In order to ensure that strategic development within the local authority takes account of future changes, it is essential that these regulations, standards, policy, plans and programmes take account of these changes. As part of this task, adaptation objectives are

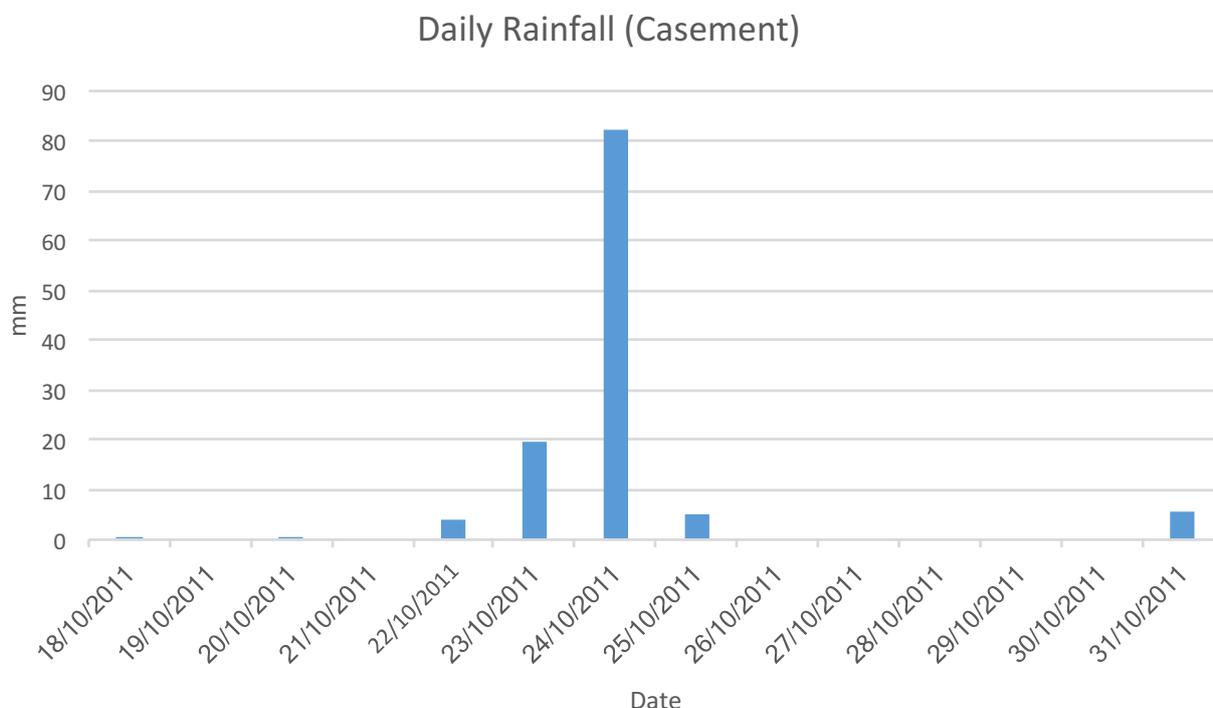


Figure 4.7. An example of a more detailed analysis of extreme weather events undertaken as part of SDCC planning. The graph illustrates precipitation amounts for an October 2011 extreme precipitation event based on data from Casement Aerodrome.

identified that can be integrated through identified and existing policy, legislation and strategies and into local planning and service delivery. Examples of adaptation management objectives might include ensuring that new buildings are designed with climate in mind and that development proposals maximise the role of green and blue infrastructure for flood storage and mitigation.

4.4 Identifying, Assessing and Prioritising Adaptation Options

Now that the impacts and risks posed by climate change have been identified, characterised and prioritised, this step in the tool supports local authorities in the identification and assessment of appropriate adaptation options.

4.4.1 Identifying adaptation options

As part of this task, a wide range of adaptation options are identified for each of the identified priority climate risks and for implementation in the short and medium to long term. Options are first identified for the medium to long term and, following this, options are identified for the short term that will offset the adverse impacts of current climate changes and extreme weather events and will build capacity to implement medium- to long-term options (e.g. awareness raising, monitoring). Short-, medium- and long- term options are then

characterised according to their ability to build adaptive capacity and to deliver adaptation actions. Options are also classified according to adaptation type (grey, green and soft).

4.4.2 Assessing adaptation options

Now that a wide range of adaptation options have been identified and an initial characterisation has been undertaken, this task supports users in determining which adaptation options best suit their adaptation needs and objectives. Adopting a multi-criteria-based approach, this involves assessing identified adaptation options according to a number of criteria, including their effectiveness in reducing vulnerability to the impact in question and/or enhancing their adaptive capacity; and the costs associated with the implementation of the option (ranging from costs similar to a municipal works project to very expensive and requiring external assistance) in terms of technical, social and institutional complexity, decision scale, level of regret, mitigation co-benefit and flexibility.

4.4.3 Prioritising adaptation options

As part of this task, adaptation options are prioritised for implementation in the short, medium and long term and according to Figure 4.8.

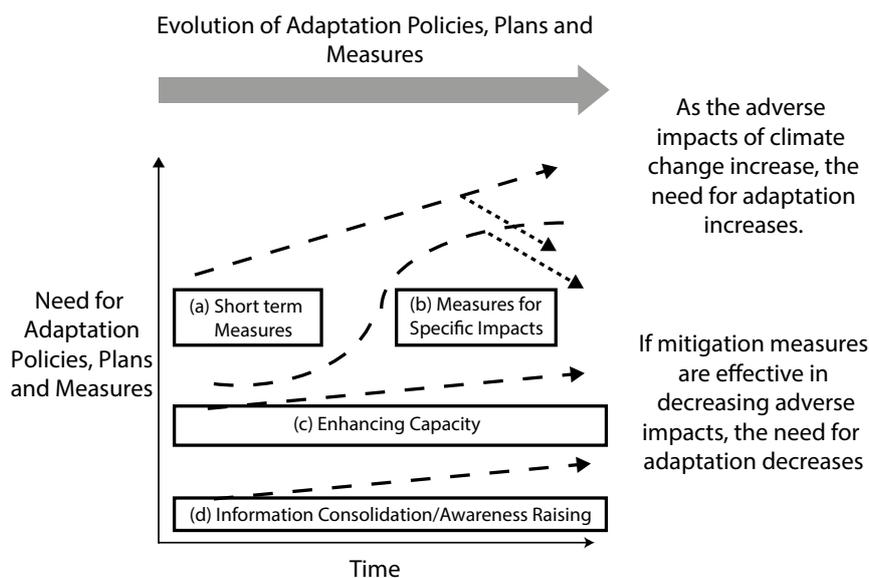


Figure 4.8. Conceptual framework for the identification and prioritisation of adaptation measures.

4.5 Developing Pathways and Drafting a Strategy

This step supports users in developing an adaptation plan through the adaptation pathway approach. The adaptation pathway approach (also referred to as the route map approach or decision pathways approach) is a new planning approach that has been developed to address deep uncertainties in policymaking processes and to design robustness and flexibility into the adaptation strategy itself (EEA, 2013). Rather than taking an irreversible decision now concerning which one or two adaptation options would best cope with climate change (which can lead to maladaptation and lock-ins if the climate scenarios planned for do not emerge), it encourages decision makers to postulate “what if” outcomes and sequence the implementation of different and incremental measures over time (e.g. IMCORE – <http://www.coastaladaptation.eu/index.php/en/>), so that options are left open to deal with a range of possible different futures (Jeuken and Reader, 2011). This approach aims to ensure that whatever short- to medium-term plan is adopted, it is set in a

framework that will not be maladaptive if future climate change progresses at a rate that is different from that predicted to be the most probable today (Reeder and Ranger, 2011). On this basis, decision makers commit to short- and medium-term actions and establish a plan that can adapt over time to meet changing circumstances and ensure resilience in the longer term.

4.6 Implementation, Monitoring and Review

Planning for adaptation is only the first step. Adaptation is an iterative learning process of planning, implementation and review. This is indicated by the arrow circling back from step 6 to step 1 (Figure 4.2). It is important to monitor, evaluate and review the performance of adaptation options/plans. This can be undertaken in terms of the identified adaptation objectives specified in step 3, recognising that adaptation plans also need to be responsive to new information when it becomes available.

5 Assessing the Impact of ICIP Phase 2 Activities

As illustrated in Figure 5.1, ICIP phase 2 developments have resulted in increased numbers of unique users accessing the CIP prototype. As detailed in Table 5.1, ICIP phase 2 developments have resulted in a sharp increase in the number of sessions, unique users and page views. In contrast, the average number of pages viewed per session and average session duration have decreased.

When, however, assessing the impacts of ICIP phase 2 activities in increasing user uptake, it is essential that both outreach activities undertaken as part of project development and increased awareness of climate change among both project stakeholders and the general public are considered. Informal and

formal engagement and outreach activities formed a key focus of ICIP phase 2 development and involved presentations at national and international conferences, presentations of ICIP as part of national and international workshops, and also training activities undertaken in house with local authority representatives.

When examining numbers of users accessing the CIP prototype, it is clear that outreach activities are driving user traffic to the CIP prototype. Notably, the CIP prototype was presented at a Climate Change Adaptation Guideline Workshop held in the Department of Environment, Community and Local Government in Dublin, which resulted in increased

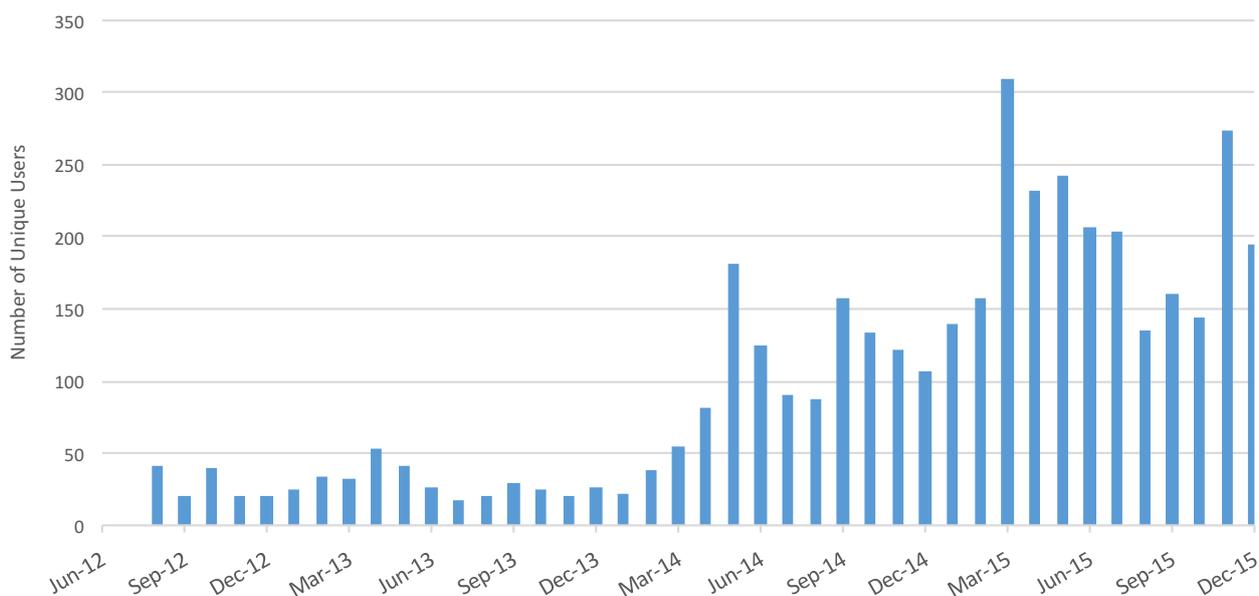


Figure 5.1. Number of unique users accessing ICIP on a monthly basis.

Table 5.1. User statistics for ICIP Phase 2 development

Statistic	ICIP phase 1	ICIP phase 2
Sessions	2628	8532
Unique users	277	3293
Total page views	27,262	67,429
Pages per session	10.37	7.9
Average session duration	14:36	8:39

number of users accessing the resource during this period. Similarly, a series of three regional adaptation seminars were held in November 2015, which resulted in a sharp increase in numbers of unique users

accessing the CIP prototype. A sharp increase in users was also apparent in March 2015; this has been attributed to the launch of the IPCC AR5 synthesis report.

6 Options for Operationalising ICIP

To date, research on the ICIP has been project based and commenced in 2010 by the Coastal and Marine Resources Centre (CMRC) using competitively won funding awarded under the EPA Science, Research, Technology and Innovation for the Environment (STRIVE) Programme. This initial scoping phase identified the best technical options for the design of a CIP, established agreements with data holders and determined the needs of the end user community in order to develop a prototype CIP. Subsequent funding was awarded under the EPA STRIVE Programme in 2013 to improve the usability of this prototype and expand its capabilities. This has involved upgrading the prototype technically in terms of the underpinning data and data management, by improving the front-end of the platform and by developing tools to support decision making for climate adaptation. This has been achieved using a partnership approach with stakeholders and, at the end of the project, a fully operational platform was delivered.

To date, project-based funding has been advantageous in allowing for the rapid development and successful demonstration of a functional CIP prototype. However, project-based funding poses a number of challenges with implications for the scope of services developed (EEA, 2015). For example, a challenge for project-funded platforms is the relative strength of the associated political mandate, which has implications for the development of the platform content, engagement of stakeholders and building the market compared with the short-term funding base. In addition, it is difficult for a project-based platform to encourage others to contribute to the development of services available on the platform, i.e. the co-design and co-production of content (EEA, 2015).

Although there is currently no strategic funding and development model for platform development, policy-mandated and supported platforms can provide a longer term perspective, depending on whether that funding is short or long term. In addition, policy-supported and mandated platforms provide political mandate and connections to ongoing or future

adaptation policy development. Experience has shown that the nature of funding of adaptation platforms changes through time, with initial development that is funded using project-based resources and then subsequently switched to policy support, reflecting an altered role of the platform (e.g. Austria, Finland, Germany and the Netherlands).

In order to operationalise ICIP, it is essential that a strategic plan is developed that outlines current direction, scope and proposed development, in both the short and the long term. Such a plan can then be used to effectively modify available capabilities and resources, as well as to communicate and engage users, contributors and collaborators. As a result, there is a requirement to establish a more long-term and strategic direction through policy-supported and/or -mandated funding mechanisms. This funding must account for a range of ongoing and future resource considerations, which include the housing of the system, future proofing, platform integrity, and outreach and training.

6.1 Housing of the System

ICIP has a significant data-handling requirement and this is expected to increase in the future as new datasets become available, e.g. CMIP6, and therefore it is proposed that the platform is deployed with a dedicated service provider such as ICHEC (Ireland's High-Performance Computing Centre). The reasons for selecting such a centre are that:

- It can provide the portability and flexibility required and it has the storage capacity to allow for growth as ICIP evolves.
- It already holds significant levels of data, as it already supplies data-management solutions to several government agencies.
- It has comprehensive technical support, which should ensure uninterrupted operation and maintenance and allow for troubleshooting and periodic technical updates as required/indicated by end users.

6.2 Future Proofing

The fundamental system architecture is being developed with evolving technologies and data requirements in mind. The system is distributed and expandable and will allow for the incorporation of “big data”. In addition, mechanisms have been put in place to ensure a high level of system optimisation and monitoring. For an operational version, however, quarterly technical reviews by an experienced developer will still be required, as there will need to be additional development to:

- ensure that the system meets users’ requirements and expectations;
- keep pace with technical developments;
- incorporate new datasets and end user tools as, and when, they become available.

6.3 Platform Integrity

Once operational, ICIP will have to remain credible to its end users and therefore will require (1) the expertise of a dedicated climate scientist, (2) an editorial board to provide oversight, with membership to include Met Éireann, EPA, OPW and others to be agreed), and (3) a pool of suitably qualified expert

reviewers (academic/industry researchers) to ensure that:

- existing end users are continually engaged and potential new users brought on board;
- feedback from end users is encouraged, channelled and responded to by a suitably qualified expert;
- training on updated aspects of ICIP is provided;
- future data sets are assessed for quality and relevance prior to any incorporation into ICIP;
- existing relationships with current data providers are maintained and relationships with new data suppliers are developed;
- continuous benchmarking of ICIP against international platforms is conducted and evolving international best practice accommodated.

6.4 Outreach and Training

When operational, ICIP will need to be promoted to encourage as wide a community of use and practice as possible and provision will need to be made to train this community in both the initial use of ICIP and subsequent updates. This will require targeted promotion (traditional and non-traditional media) and the organisation of bi-annual workshops that are tailored to the community’s requirements.

7 Conclusions and Recommendations

7.1 Conclusions

The global climate is changing and these changes are expected to continue and intensify in the future. Ireland's climate is expected 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 to avail ourselves 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 its impacts and this information is considered 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 support practical climate adaptation decision making.

Through the development of ICIP phase 1, substantial progress was made in developing a CIP specifically tailored to the needs of adaptation decision making in Ireland. It has demonstrated the potential for employing existing information and data in meeting the challenge of initiating, planning for and managing climate change adaptation. In addition, ICIP phase 1 has demonstrated the potential of the ICIP project to act as a boundary organisation, bridging the science–policy interface and making the information required for adaptation decision making available, relevant and usable by decision makers. ICIP phase 2 development has further developed the CIP prototype by enhancing the system architecture, improving the usability of the prototype and providing additional functionality and tools. This has been achieved in close consultation with project stakeholders and end users.

In collaboration with project stakeholders, the second phase of ICIP development has identified the key enhancements to the existing CIP prototype and developed targeted and policy-relevant decision support frameworks that are underpinned by

information and data made available through the CIP prototype, as listed below:

- To address the requirement to increase the usability of the CIP prototype, the underlying system architecture has been enhanced to allow for the integration of dynamic content and the overall upgrade of the CIP prototype front-end.
- In order to support users in quickly accessing information made available through the CIP prototype, key information panels have been developed for all pages allowing users to become acquainted with the information without the requirement to read through all the information contained on each page. In addition, ICIP phase 2 developments have aimed to ensure the credibility of information on the prototype by implementing a referencing system that allows users to quickly access information on the references employed, including source information, all bibliographic information and abstracts where available.
- ICIP's prototype *Climate Information Tool* forms a key resource of the CIP prototype. This has been upgraded substantially to allow for increased usability and a range of users (basic to expert). In addition, the inclusion of observed climate information and application programming interface-based access from key areas of improvement.
- On the basis of available climate and adaptation information for Ireland and in accordance with the requirements of the NCCAF (2012), the *Local Authority Adaptation Support Wizard* has been developed and made available through the CIP prototype to support local authorities in the development of their adaptation plans. This tool adopts a policy-first approach and aims to help local authorities in making best use of information made available through the CIP prototype in the development of their local area adaptation plans.

7.2 Recommendations

Following the first phase of the ICIP project, the second phase of the ICIP project has demonstrated the potential for employing a national CIP to support

policy-guided adaptation planning in Ireland and particularly at the local level. Nonetheless, in order to operationalise the prototype, particularly in supporting decision makers (local, sectoral and national) in fulfilling their obligations under the NCCAF (2012), the Climate Action and Low Carbon Development Bill (2015) and the forthcoming NAF (expected 2017), further development is recommended in a number of key areas:

- the provision of additional mechanisms for decision support that directly address the needs of adaptation decision making in Ireland, e.g. NCCAF (2012);
- continued user engagement and training to ensure that information and data delivered through the CIP prototype are of direct relevance and tailored to decision making in Ireland;
- the improvement of technical aspects of the CIP prototype;
- the development of a funding programme to support operationalisation of ICIP.

7.2.1 Improved decision support

The second phase of the ICIP project was specifically targeted at helping local authorities in the preparation and development of their adaptation strategies. For example, the *Local Authority Adaptation Support Wizard* was developed through ICIP phase 2 to facilitate climate adaptation decision making among local authorities and in accordance with the requirements of the NCCAF (2012).

In line with national and international guidance on adaptation decision making [e.g. EU Adaptation Strategy and the NCCAF (2012)], and in order to further develop and operationalise ICIP and to facilitate horizontal and vertical integration of adaptation across all policy areas and levels of governance, the requirements of sectoral decision making must now be considered. In addition, as climate and adaptation science progresses and as the needs of existing and new stakeholders evolve as they progress through the adaptation policy cycle, it is essential that ICIP remains current (i.e. is updated based on the evolving science,

data and practice) and continues to meet the changing needs of existing and new users.

7.2.2 User engagement and training

User engagement and training has formed a key focus of the development process and has aimed to ensure that the prototype CIP meets the requirements of key stakeholder groups. However, in order to ensure the continued development and effective uptake of the resource by these key stakeholder groups, this engagement should be strengthened further in future development.

- The prototype CIP is a boundary resource, working at the science–policy interface. As a result, considering the needs of stakeholders must form a critical component of further development if the communication of scientific information is to be successful. In order to ensure that the needs of the user communities are met, it is essential that a partnership approach is adopted during the continued development of ICIP to ensure that the information and tools delivered are of relevance to users and their decision-making contexts.
- Adaptation is complex and adaptation planning poses a major challenge to decision makers. For example, through ICIP's *Local Authority Adaptation Support Wizard*, a policy-first approach to adaptation is adopted. This approach advocates beginning at the scale of the adaptation problem and adopting a participatory approach, and it therefore requires significant input from the user community. When attempting to foster uptake of these tools by user communities, it has been demonstrated that those tools that offer focused guidance and user support, including training programmes, tend to be more popular and used more often. As a result, it is recommended that user training would form a key part of the further development of ICIP.

7.2.3 Technical and resource considerations

The CIP prototype has significant data housing and handling requirements and this will be expected

to increase into the future. In order to future-proof the system and allow for further enhancement and optimisation, it is recommended that the CIP prototype is deployed within a dedicated service provider such as ICHEC. This is because:

- It can provide the portability and flexibility required and it has the storage capacity to allow for growth as ICIP evolves.
- It already holds significant levels of data as it already supplies data-management solutions to several government agencies.
- It has comprehensive technical support, which should ensure uninterrupted operation and maintenance and allow for troubleshooting and periodic technical updates as required/indicated by end users.

7.2.4 Funding an operational ICIP

Following from the development of the prototype CIP resource and in order to ensure the continued update and development of the prototype resource by the key stakeholder groups, a strategic roadmap for development is required, which is underpinned by policy-supported mechanisms for funding. This roadmap should outline the transfer of ICIP from its current project-based funding mechanism to a policy-supported funding mechanism. Following from the review of options for operationalising ICIP undertaken as part of ICIP phase 2 activities, a stakeholder engagement strategy should be put in place to determine the most effective options for providing strategic and policy-supported funding.

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Abbreviations

CIP	Climate information platform
EPA	Environmental Protection Agency
EU	European Union
GHG	Greenhouse gas
ICHEC	Ireland's High-Performance Computing Centre
ICIP	Irish Climate Information Platform
NAF	National Adaptation Framework
NCCAF	National Climate Change Adaptation Framework
OPW	Office of Public Works
SDCC	South Dublin County Council
STRIVE	Science, Research, Technology and Innovation for the Environment
UCC	University College Cork

AN GHNÍOMHAIREACTH UM CHAOMHNÚ COMHSHAOIL

Tá an Gníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaoil a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaoil 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 comhlionta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.

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

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

Ár bhFreagrachtaí

Ceadúnú

Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaoil:

- saoráidí dramhaíola (*m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistriúcháin 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 peitрил;
- scardadh dramhuisece;
- 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 dhírú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhrámhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a idíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaoil.

Bainistíocht Uisce

- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uisce idirchriosacha agus cósta na hÉireann, agus screamhuisecí; 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 gComhshaoil

- 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 Chomhshaoil na hÉireann agus Tuarascálacha ar Tháscairí*).

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn

- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis ceaptha 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 shainiú, 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 gcomhshaoil 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 tairmí 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 gcomhshaoil ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaoil (*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 chosaint agus a bhainistiú.

Múscaill 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 Iáinimseartha, 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 comhaltáí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair inné agus le comhairle a chur ar an mBord.

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The Development of an Irish Climate Information Platform (ICIP) – Phase 2 (2013–2015)



Authors: Barry O'Dwyer and Jeremy Gault

Identify Pressures

Ireland's climate is changing in line with global trends and these changes are expected to continue and intensify, posing significant threats to Ireland's environment, society and economy. Due to the inertia within the climate system, which takes centuries to adjust to increased concentrations of greenhouse gases (GHGs), the benefits of present and ongoing efforts to mitigate GHGs emissions will not be felt for centuries or more. Therefore, to prevent or minimise the adverse impacts of climate, planned and anticipatory adaptation to climate change and the impacts of these changes is urgently required. This needs to be underpinned and supported by the delivery of timely and accurate information on current climate conditions, projected changes in these, likely impacts and options for adaptation to decision makers all presented in a user-friendly way. 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 to provide decision makers with a one-stop web-based resource of climate and adaptation information on Ireland (<http://www.climateireland.ie>).

Inform policy

ICIP phase 1 (2010–2013) identified the best technical options for the design of a national CIP, established agreements with data holders, determined the needs of the end-user community and developed a CIP prototype. The production of ICIP Phase 2 (2013–2015) has built upon the existing CIP prototype, improved its usability and expanded its capabilities. This has involved:

- the redevelopment of the CIP prototype system architecture providing for the deployment of an enhanced, more dynamic and user-friendly interface;
- the upgrading of the Climate Information Tool, a key resource within the CIP prototype, in terms of look and feel, through the inclusion of additional datasets (e.g. observed climate information) and the deployment of advanced data selection options;
- the development of a Local Authority Adaptation Support Wizard that is specifically designed to support local authorities in developing their local area adaptation plans and by taking full advantage of and integrating the different sources of information made available through the CIP prototype;
- on the basis of international experience, making recommendations in relation to further ICIP development.

Develop solutions

The production of ICIP Phases 2 has further developed the existing CIP prototype (developed as part of ICIP Phase 1 activities (2010–2013)) to support planning for climate change adaptation at the local level and in accordance with the requirements of national climate policy.