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Climate - Water - Sustainability
Identifying pressures • Informing policy • Developing solutions

The Development of an Irish Climate Information Platform (ICIP) - Phase 1 (2010-2013)

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Comhshaol, Pobal agus Rialtas Áitiúil
Environment, Community and Local Government

www.epa.ie

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 Environmental Assessment
- Office of Radiological Protection
- Office of Communications and Corporate Services

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

EPA Research Programme 2014–2020

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EPA Research Report

Prepared for the Environmental Protection Agency

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

1 Introduction

Warming of the climate system is now unequivocal. Observations indicate that global surface temperatures have increased by on average 0.85°C since 1850, and it is now considered extremely likely that human influence, particularly through the emission of greenhouse gases (GHGs), has been the dominant cause of this warming since the mid-20th century. In order to reduce the long-term impacts of climate change, two complementary policies have been adopted: mitigation and adaptation. Mitigation actions aim to limit warming through the reduction of GHG emissions and the increasing of carbon sinks. However, due to latencies in the response of the global climate system, even if contemporary actions to limit warming are successful in minimising the impact on the global climate system, many of the impacts of climate change are 'locked-in' for some decades to come and are expected to continue and intensify in the short to medium term. As a result, adaptation, which aims to enable society to better cope with, manage or adjust to changing climatic conditions, is now required.

Adaptation has been defined by the Intergovernmental Panel on Climate Change (IPCC, 2007) as "*adjustment or preparation of natural or human systems to a new or changing environment, with the aim of moderating harm or exploiting beneficial opportunities in natural or human systems in response to actual or climate change stimuli or their effects, which moderates harm or exploits beneficial opportunities*".[1] It can be reactive or proactive. Given the increased knowledge of expected climate change impacts, a planned and strategic approach to adaptation is required to reduce risk and avail of any opportunities that climate change might bring.

For Ireland, there now exists a large body of work on current and anticipated impacts of climate change and it is considered that there is a robust knowledge base to support the process of adaptation planning. However, this information is disparate, being held by a wide range of organisations, in a variety of formats and with differing means of access and, as a result, it is extremely difficult for decision makers and citizens alike to access it. Contemporary international experience has demonstrated that centralised online platforms providing harmonised scientific information adapted to end-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.

2 Ireland's Climate Information Platform

Adopting a phased approach, the EPA-funded project Ireland's Climate Information Platform (ICIP) aims to develop a one-stop web-based resource of climate and adaptation information that is specifically designed to facilitate climate adaptation decision making in Ireland. The first phase of the ICIP project aimed to develop a prototype Climate Information Platform (CIP) for Ireland.[2] In order to best design and develop a prototype CIP, an extensive scoping strategy was first undertaken in order to establish the requirements of decision making in Ireland for climate adaptation planning. This scoping strategy examined the existing status of adaptation planning in Ireland, current and historical climatic (observed and projected) information for Ireland, and it reviewed existing international climate and adaptation information platforms.

- Currently, Ireland can be considered to be at the early stages of the adaptation planning process and climate adaptation has not been considered a high priority for decision making in Ireland. This

1. IPCC, 2007. Summary for policymakers. *In:* Parry, M.L. et al. (Eds) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, UK. pp. 7–22.

2. For clarity, the 'prototype CIP for Ireland' is referred to as 'prototype CIP' throughout this report.

can be attributed to a lack of a statutory requirement to address climate adaptation and also the lack of awareness and understanding amongst decision makers and the general public. However, the recent publication on the National Climate Change Adaptation Framework (NCCAF)[3] has made some progress in addressing this issue by requiring the integration of climate adaptation into spatial and sectoral planning practices.

- A wide range of information on the current and expected impacts of climate change for Ireland is currently available and should support the process of climate adaptation in Ireland. However, in its current state, a number of barriers still exist to the utilisation of this information. These include, amongst others, the distributed nature of this information, differences in methods of deriving information and also in the spatial and temporal scales of this information. In order for decision makers to effectively employ this information in their current planning practices and to overcome the uncertainties in it, specific frameworks and tools are required.

- Currently, there are eight European web-based platforms that are considered to provide a broad coverage of adaptation. In general, these are based around three key areas of information provision, namely awareness raising, provision of climatic data, and decision support.

On this basis and in order to meet the requirements of adaptation decision making in Ireland, the prototype CIP has been designed and developed in order to:

1. **Improve users' understanding of climatic and adaptation science**
   In order to enhance understanding and awareness of climatic and adaptation science, thus overcoming the more common barriers to climate change adaptation, such as denial and scepticism, the prototype CIP provides a climatic and adaptation science informational resource. This resource addresses key issues such as observed evidence of climate change, the process of developing future climate projections, the uncertainties in projecting future climate changes and their impacts, and it outlines how management approaches (e.g. adaptive management) can be successfully implemented in spite of these uncertainties.

2. **Act as a centralised repository of climatic information for Ireland**
   In order to provide climatic and adaptation information and data through the prototype CIP, three individual tools have been developed: the *Climate Information Tool*, the *Climate Hazard Scoping Tool*, and the *Sectoral Adaptation Information Tool*. The *Climate Information Tool* integrates and standardises (temporally and spatially) existing and downscaled projections of climatic changes for Ireland and allows users to examine and query the available data, thus overcoming issues such as access to information and differences in temporal and spatial scales. The *Climate Hazard Scoping Tool* examines current and projected climate impact analyses and adopts a vulnerability-based approach to facilitate users in assessing how climate change might exacerbate existing exposure to climatic hazards. As climate change will result in a range of different challenges and with varying opportunities for the key economic sectors of the Irish economy, a *Sectoral Adaptation Information Tool* has been developed that provides decision makers with the requisite information to determine what climate change might mean for their sector of operation and how they might begin to plan for adaptation.

3. **Provide a range of frameworks and tools to allow users to employ climatic information and data in their current planning practices**
   In order to allow decision makers to effectively employ existing climatic information in their current planning practices, a number of decision support tools have been developed, including the *Adaptation Support Tool* and *Ireland's Adaptive Social Ecological Systems Simulator* (*iasess*). The *Adaptation Support Tool* facilitates users

3. DECLG, 2012. *National Climate Change Adaptation Framework: Building Resilience to Climate Change*. Department of Environment, Community and Local Government, Dublin, Ireland.

through the adaptation planning process from identifying their area of planning and the key stakeholders involved to developing and implementing an adaptation plan. This tool adopts a participatory mapping approach that functions as a vehicle for stakeholder deliberation and engagement.[4] Moreover, in order to help users overcome the uncertainties in climate projection information, this 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 context. Building upon previous research undertaken as part of the EPA-funded Coastal Climate Adaptation and Development (CLAD) project, a web-based decision support tool, *iasess*, has been developed to assist decision makers in scoping their locally specific vulnerabilities to climate change, and then to select and evaluate adaptation options to improve local resilience to climate change.

3 Conclusions and Recommendations

Phase 1 of the ICIP project has made substantial progress in designing and developing a prototype CIP and has demonstrated the potential to serve as a key resource for communicating and supporting the analysis of impacts, vulnerabilities and adaptation options. As part of this process, the key areas of information provision required for the initiation and development of adaptation responses in Ireland were identified. The prototype CIP has been successful in collating and integrating a wide range of spatial and non-spatial data sets that are of significant importance in the development of adaptation planning in Ireland. Moreover, the prototype CIP has also designed and developed specific resources, frameworks and tools to allow the employment of these data in the development of adaptation plans. Nonetheless, in order to operationalise the resource and in particular to effectively support decision makers in fulfilling their obligations under the NCCAF[3], further development of the resource is required.

- Currently, the prototype CIP offers a number of high-level scoping tools (e.g. national level) to facilitate decision makers in coming to an understanding of the implications of climate change for their area of operation. To facilitate decision makers in meeting the specific requirements of the NCCAF[3], further development of the prototype CIP toolbox is required. In addition, in order to best develop these tools, it is essential that continued user engagement and training forms a key component to ensure the uptake of the resource by the key stakeholder groups.

- The technical design and development of the prototype CIP has been based on a browser/server (B/S) system architecture and provides for both flexibility and expandability for data providers and users alike. However, in order to further develop the resource, a number of improvements can be made to ensure its full automation, improved system performance and data management (e.g. the data loading component can be improved to support more data formats and standards), and improved data interrogation and display.

- In order to ensure the uptake and operationalisation of the prototype CIP, it is essential that a roadmap for further development and operationalisation of the resource be defined. This roadmap should be based on a review of international best practice, extensive stakeholder engagement and consultation, and should examine issues regarding embedding, governing and resourcing of a fully operational CIP.

4. Stocker, L., Burke, G., Kennedy, D. and Wood, D., 2012. Sustainability and climate adaptation: using Google Earth to engage stakeholders. *Ecological Economics* **80:** 15–24.

1 Introduction

Currently, there is a large body of work on current and anticipated impacts of climate change for Ireland, and it is now considered that there is a robust knowledge base on which to begin the process of adaptation planning (Desmond et al., 2009). However, this information remains distributed amongst a large number of institutions and agencies and it is extremely difficult for decision makers and citizens alike to access it in an efficient and effective manner.

Contemporary international experience demonstrates that centralised (e.g. national and international) online platforms providing harmonised scientific information adapted to end-user needs can effectively support practical decision making. On this basis, the Environmental Protection Agency (EPA)-funded project Ireland's Climate Information Platform (ICIP) aims to develop a CIP that will provide decision makers in Ireland with a one-stop web-based resource of climate and adaptation information and data for Ireland. It was subsequently decided to adopt a phased approach to this development, in which the first stage would, in consultation with potential end-users and data providers, design and populate a prototype CIP.

This report details ICIP Phase 1 development and more specifically the development of a prototype CIP for Ireland. This chapter provides an overview of climate change, adaptation and the role of CIPs in facilitating adaptation responses. Chapter 2 scopes the potential for developing a prototype CIP by identifying the needs of the key user groups, reviewing available climatic information and data for Ireland, and examining existing international CIPs to inform the development process. Chapter 3 describes the delivery of this vision, outlining and describing the functionality of the prototype CIP, whilst Chapter 4 offers conclusions and recommendations for the further development and operationalisation of the developed prototype CIP.

1.1 Climate Change

Warming of the climate system is now unequivocal and observations indicate that global surface temperatures have increased by on average 0.85°C since 1850 and it is now considered virtually certain that the upper ocean (0–700 m) has warmed by 0.11°C per decade over the period 1971–2000, while it is considered likely that the oceans have warmed between the 1870s and 1971 (IPCC, 2013). This warming has resulted in, amongst others, the loss of mass from the Greenland and Antarctic ice sheets, shrinking of glaciers globally, a decrease in the extent of Arctic Sea ice and Northern Hemisphere spring snow cover, an increase in average rates of sea-level rise (SLR) and modifications of weather patterns (IPCC, 2013).

It is now considered extremely likely (>95%) that human influence, particularly through the emission of greenhouse gases (GHGs), has been the dominant cause of the observed warming since the mid-20th century (IPCC, 2013). In order to reduce the long-term impacts of climate change, mitigation actions that aim to limit warming through the reduction of GHG emissions and by increasing the capacities of carbon sinks, e.g. through reforestation, have been implemented. However, even if contemporary actions to mitigate anthropogenic GHG emissions are successful in minimising the human impact on the global climate system, due to latencies in the response of the global climate system, many of the impacts of climate change are 'locked-in' for some decades to come and are expected to continue and intensify in the short to medium term (IPCC, 2013).

For Ireland, observed changes are in line with global trends and Ireland's climate is projected to change significantly over the coming decades (Gleeson et al., 2013). Observed changes indicate that for Ireland, the annual average surface air temperature has increased by approximately 0.8°C since 1900 (Walsh and Dwyer, 2013). Projections indicate that this warming is expected to continue with increases in average temperatures of ~1.5°C projected by the end of the century (Nolan et al., 2013a). For precipitation, when compared with the period 1961–1990, observations indicate that average levels of national rainfall have increased by approximately 60 mm (5%) for the period 1981–2010 (Walsh and Dwyer, 2013). In contrast, annual average projections of rainfall suggest a reduction for the end of the century, noting that this decrease, however, is subject to a relatively high level of uncertainty. However, when examined by season, a clear signal of increasing level of precipitation in winter (0–14%) and decreasing precipitation in summer is apparent with reductions of 4–20% suggested (Nolan et al., 2013b). Satellite observations indicate that sea levels around Ireland have risen by approximately 4–6 cm since the early 1990s and long-term measurements obtained from a tide gauge situated at Newlyn in Cornwall, reflective of the situation to the south of Ireland, confirm this trend indicating a mean SLR of ~1.7 mm per year since 1916 (Dwyer and Devoy, 2013). This trend is projected to increase, with global projections indicating an SLR of up to 0.98 m by the end of the century relative to the period 1986–2005 (IPCC, 2013), while projected changes for the Irish sea indicate a sea-level rise of approximately 0.47 m by the end of the current century (Olbert et al., 2012).

Globally, climate change will have wide-ranging effects on the environment, society and the economy and associated sectors, including water resources, agriculture and food security, human health, terrestrial environments and biodiversity and coastal zones. For Ireland, changes in rainfall patterns are likely to lead to increased risk of flooding and water shortages (Bastola et al., 2011; Hall et al., 2013). Rising 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 potentially severely increase rates of extinction for many habitats and species (Byrne et al., 2003) and will have a profound effect on our ability to conserve species and the habitats on which they depend (Coll et al., 2013). Increasing sea levels may result in coastal inundation and erosion when combined with increased levels of storminess and the increased risk of storm surge (Flood and Sweeney, 2012). Moreover, the occurrence of extreme weather events is projected to increase with potentially devastating consequences (IPCC, 2012). In contrast, climate change will also offer opportunities for Ireland's key economic sectors. For example, increasing temperature and drier summers will likely prolong the duration of the present peak tourism months (May–August) 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 carbon dioxide may result in increased autumn and spring grass yields, which will allow livestock farms increase profit by exploiting increases in grass production and reducing the use of concentrate feed (Teagasc, 2010), while adverse impacts of climate change experienced elsewhere may create new market opportunities for Irish agriculture (RIA, 2003).

1.2 Adaptation

Two complementary policies have been adopted to respond to the threat of climate change: mitigation and adaptation (Fig. 1.1). The first policy pursued in response to climate change, mitigation, has been defined as "*anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases*" (IPCC, 2007) and aims to alleviate the cause of climate change by reducing the concentration of GHGs in the atmosphere. The second policy response, adaptation, aims to enable society to better cope with, manage or adjust to changing climatic conditions. Adaptation has been defined by the Intergovernmental Panel on Climate Change (IPCC, 2007) as "*adjustment in natural or human systems in response to actual or climate change stimuli or their effects, which moderates harm or exploits beneficial opportunities*". In summary, mitigation aims to address the causes of climate change while adaptation aims to enable society to better cope with, manage or adjust to climate change (IPCC, 2001).

Adaptation may be reactive or proactive, undertaken autonomously or as part of a specifically directed strategy. It may aim to build adaptive capacity, thereby increasing the ability of individuals, groups or organisations to adapt to climate change, or may involve the implementation of adaptive interventions

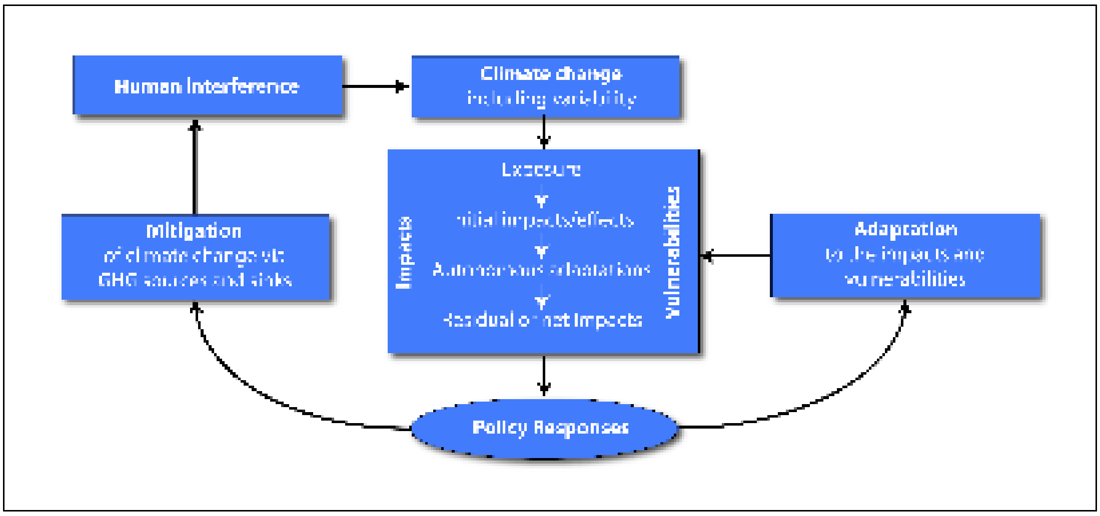

Figure 1.1. Summary diagram illustrating policy responses (mitigation and adaptation) to climate change (Smit et al., 1999). GHG, greenhouse gas.

(i.e. transforming that capacity into actions). Adaptation actions/responses can be grouped into three broad categories (EEA, 2013):

1. 'Grey' actions refer to technological and engineering solutions and examples include building or strengthening of coastal and river flood defence/dykes;

2. 'Green' actions refer to ecosystem-based approaches that employ the multiple services of nature and seek to employ nature to conserve or enhance carbon stocks, and reduce carbon emissions caused by ecosystem degradation and loss. When green adaptation actions are part of an organised spatial plan, they are referred to as 'Green Infrastructure'; and

3. 'Soft' actions refer to managerial, legal and policy approaches that alter human behaviour and practices.

Until recently, many adaptive actions have been both autonomous and reactive as individuals, households and organisations have independently adjusted their circumstances due to experiences or perceptions of climate risk. However, these autonomous adaptations are considered to be less than optimal, as substantial inefficiencies and costs are typically incurred when compared with adaptation undertaken strategically. Autonomous adaptation can also have unintended consequences for other individuals or sectors, resulting in maladaptation. Maladaptation occurs when an action increases rather than decreases overall vulnerability to climate change impacts (DECLG, 2012). Given the increased knowledge of expected climate change impacts, a planned and strategic approach to adaptation is required to reduce risk and avail of any opportunities that climate change might bring. As different sectors are often closely interlinked, adaptation is a cross-sectoral issue requiring horizontal integration. In addition, adaptation is an issue for all levels of governance and cuts vertically across different levels of decision making from the international (e.g. European Union (EU)), to the national level and from the national level to the regional and local levels.

Adaptation policy in Europe is relatively new and is being progressed principally through the EU Strategy on Adaptation to Climate Change (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, 16 European Environment Agency (EEA) member countries, including Ireland, have developed national adaptation strategies (EEA, 2013). Ireland's National Climate Change Adaptation Framework (NCCAF) (DECLG, 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 are now mandated 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, therefore, a wide range of policy areas and, 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.

1.3 Delivering Adaptation Responses

Until recently, decision makers in Ireland tended to rely on past records of climate to plan for the future. However, in the context of planning for a future that includes projected global climate change, basing these plans on past records will prove inadequate, and information is now required on how human-induced warming may affect key climatic parameters and the effects these changes will have for Ireland. Arriving at an understanding of current and future climate change impacts at this scale is a major challenge for decision makers and requires consideration of a wide range of potential impacts, where and when these may occur and how different elements of the social, environmental and economic communities might respond. The adaptation policy cycle (Fig. 1.2) provides a framework to assist users 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 approach adopted. Once this first iteration is complete, the cycle can begin again with a reassessment of risks and vulnerability. The steps in the cycle can then be reconsidered periodically in order to ensure that adaptation decisions are based upon 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 successes and failures of adaptation actions (EEA, 2013).

1.4 Uncertainty

Unfortunately, in planning for the future, key aspects of information, including climate change and socio-economic information, that are essential to adaptation planning are uncertain. In addition, for projected climatic information, our incomplete knowledge regarding future climate, particularly the downscaled impacts of global climate trends, results in the greatest levels of uncertainty attending local-scale climate impact projections (Fig. 1.3). However, in adaptation planning, this uncertainty should not act as a barrier to

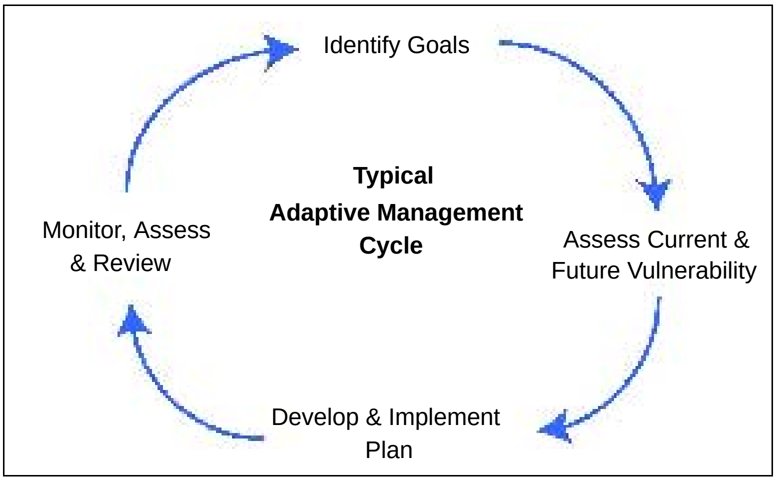

Figure 1.2. Schematic diagram of a typical adaptive management cycle.

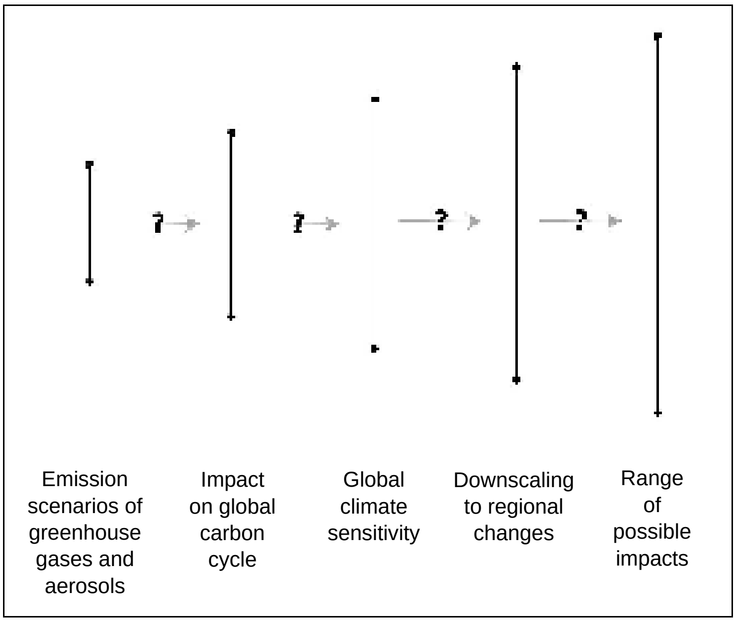

Figure 1.3. Range of major uncertainties, typical in climate change impact assessment, which result from unknowable knowledge, uncertainty in model configuration and uncertainty due to the random nature of natural forcing – commonly referred to as the cascade of uncertainty, with greatest levels of uncertainty associated with the projection of local-scale impacts.

developing and implementing adaptation responses but should be employed to ensure robustness in decision making.

When providing climate science information, there is no simple or single method for communication and, as a result, issues of uncertainty can often be misinterpreted as being of simple inaccuracy or error. In contrast to the short-term political view, the scientific community has always adopted a long-term approach and the communication of its scientific output must be just as strategic in its analysis, design, implementation and evaluation. Communication of the range of expected future climate changes and accompanying impacts must be undertaken in a clear and coherent manner, and be understandable to those requiring climate information if decision making is to be adequately supported. Failure in this regard can result in those needing to take action forming an exaggerated sense of the uncertainty (or certainty) of climate projection information.

1.5 Climate Information Platforms

Despite the recent focus on climate change, a clear awareness and understanding of its potential impacts and consequences are generally lacking and remain a key barrier to adaptation (Biesbroek et al., 2010). Until recently, most information dissemination campaigns about climate change have focused on the problem of mitigation and how citizens can help reduce GHG emissions through green energy, increased energy efficiency and other measures to reduce emissions. In contrast to mitigation, where the message about what an individual can do is rather generic, for adaptation, effective dissemination of information is often dependent on specific circumstances (as populations are not equally vulnerable), and as a result requires specifically tailored information. Moreover, adaptation strategies typically emphasise the importance of raising public awareness and capacity through information provision (Biesbroek et al., 2010).

In general, the dissemination of climatic and adaptation information in the realms of both research and practice is poorly co-ordinated, with a wide variety of different organisations contributing data in an ad-hoc manner. Usually, basic information on climate adaptation is presented by national governments or the relevant ministry responsible for adaptation. More specialised information on expected climate changes and potential impacts is made available by meteorological organisations augmented by various research institutes and programmes. The more recent programmes on adaptation and vulnerability initiatives have tended to disseminate their information through stakeholder discussions, workshops, conferences, seminars, publications and web pages. As a result, it can be difficult for decision makers and the public alike to access, interpret and integrate the information required for planning for climate change adaptation.

In order to overcome this fragmentation of information and also to facilitate a more effective level of interaction between science and policy, an increasingly common approach has been to support organisations working at the interface of science and policy so that they can fulfil a co-ordinating role in providing climate and adaptation information tailored to the needs of the end-users. One of the main tools employed to raise awareness and deliver information at the science–policy interface is websites. These can be a useful tool as, globally, computer literacy is generally high, access is virtually universal, and information can be inexpensively and easily updated and expanded. They can also provide a powerful tool in creating awareness, facilitating public understanding and informing about climate change impacts and adaptation options (Swart et al., 2009).

Currently, of the 32 EEA member countries, 15 have developed websites (EEA, 2013). However, large differences are apparent in the scope of information provided by these sites. Some contain a wide range of information, including information on climate change, sectoral and geographic impact information, and generalised adaptation guidance. However, other sites are less broad, are focused more on mitigation than adaptation, and are built around a single organisation's website rather than performing a co-ordinating role. Of the 15 members that have developed websites, eight are considered to have developed sites that provide a broad coverage in terms of adaptation (EEA, 2013).

2 Developing a Vision for a Prototype CIP

2.1 Introduction

In order to ensure that the prototype CIP addresses the needs of the key stakeholder groups in planning for climate adaptation and that its design makes optimum use of available information and data, an extensive scoping strategy was put in place. This was utilised to develop a vision for the prototype CIP and entailed the following aspects, with outcomes outlined in the subsequent sections (Fig. 2.1):

- A review of the current status of adaptation planning in Ireland;
- A review of existing climatic information and data for Ireland (observed and projected);
- A comparison and critical review of existing national CIPs; and
- Direct stakeholder engagement through the organisation of two workshops (to elicit feedback from expert users and data providers)

The output from the above was then considered and used to determine the final vision for the prototype CIP which guided development and is detailed in the final section of this chapter.

2.2 Current Status of Climate Adaptation Planning in Ireland

For Ireland, the overarching climate change policy document is the *National Climate Change Strategy* (DEHLG, 2000, 2007). The purpose of the Strategy was to show how Ireland could meet its 2008–2012 commitment of limiting its GHG emissions to 13% above 1990 levels and to demonstrate which strategy measures will position Ireland for the post-2012 period. As part of this policy, the Irish government committed to developing a national adaptation strategy.

The NCCAF (DECLG, 2012) provides the policy context for a strategic national response to climate change and calls for the development of spatial/local and sectoral adaptation plans. In order to determine the preparedness of Irish decision makers for initiating and delivering climate adaptation and to achieve the requirements of the NCCAF, a review of the current status of adaptation planning in Ireland has been undertaken by several researchers.

Spatial planning provides great potential to initiate and integrate climate adaptation objectives, particularly at the local and regional levels (Mickwitz et al., 2009). However, and for the most part in Ireland, climate risks have yet to be systematically assessed in the area of

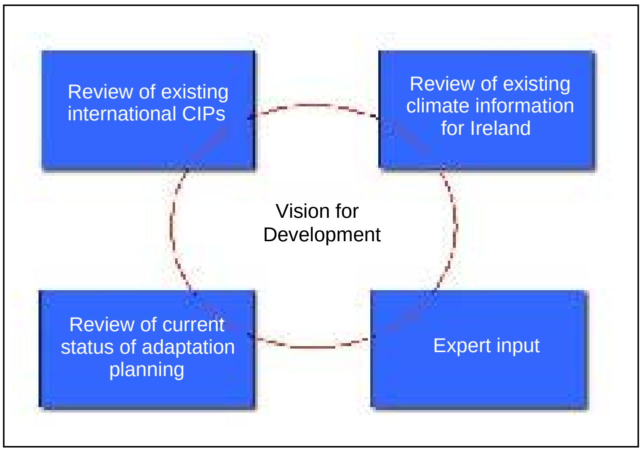

Figure 2.1. Summary diagram illustrating the framework employed in developing a vision for the delivery of the prototype Climate Information Platform (CIP).

planning (Shine and Desmond, 2011). This lack of progress in implementation has been attributed to a number of factors, the most important of which have been identified as ‘a lack of awareness’, ‘a lack of understanding of climate change and its impacts’ and ‘issues of integration’ (McGloughlin and Sweeney, 2011; Desmond and Shine, 2013; Falaleeva et al., 2013).

Awareness raising is considered a soft adaptation measure and aims to overcome the more common barriers to the initiation of climate adaptation, such as a lack of information, misunderstanding, scepticism and denial (EEA, 2013). In Ireland, a lack of awareness amongst the general public and decision makers concerning climate change and adaptation has resulted in a lack of prioritisation of climate adaptation in spatial planning. In order to overcome this barrier, increased public consensus and resultant prioritisation by elected officials is required to initiate and advance the process of climate adaptation (McGloughlin and Sweeney, 2011).

In terms of understanding, the translation of the global impacts of climate change to the local scale is required to allow decision makers redefine the problem of climate for their area of operation and begin the process of adaptation planning. For example, Falaleeva et al. (2013) suggested that although there was a general awareness of climate change amongst Irish coastal communities, there was less of an understanding of its causes and effects. In particular, the identification of the link between global processes and consequential local impacts for Irish coastal communities varied significantly and, unsurprisingly, these perceptions influenced attitudes regarding the urgency of action. As a result, it was suggested that there was a need to make information comprehensive and transparent to all and link data to the local context (Falaleeva et al., 2013).

Integration (horizontal and vertical) of climate adaptation was the third key barrier identified. Horizontal integration refers to links at a given level of government, both internally within an organisation and externally among organisations at that level. Vertical integration focuses on interactions between different levels of government (e.g. international, European, national and local). To a large extent, the challenge of climate change policy is a test of the effectiveness of policy integration across and between different policy sectors (Desmond and Shine, 2013). The publication of the NCCAF (DECLG, 2012), which provides for a strategic national response to climate change adaptation, has achieved some success in addressing issues of integration. However, in its current form, considerable potential remains for a shortfall in co-ordination between the various sectors and local authorities tasked with adaptation, resulting in a heightened risk of maladaptive outcomes. For example, the NCCAF (DECLG, 2012) currently makes no specific provision for co-ordinating adaptation between neighbouring counties, or between sectors with clearly interdependent relationships to resources – such as those of the water management and agriculture sectors. Similarly, it remains unclear how the conceptual/procedural adaptation plans of sectoral bodies will be coherently integrated with the inherently spatial adaptation plans developed by local authorities.

At the sectoral level, some Irish sectors can be considered to be at the preliminary stages of preparedness for initiating adaptation and have begun to engage with adaptation in their planning; this, however is, for the most part, driven by international and EU obligations (Kopke and O’Mahony, 2011). For example, a number of sectors have produced reports that have made a start in examining sector-specific vulnerabilities to climate change. These include marine and fisheries (e.g. Boelens et al., 2005), water management (e.g. Irish Academy of Engineers, 2007), tourism and cultural heritage (e.g. Kelly and Stack, 2009), critical infrastructure (Mackey and Bree, 2009) and business (e.g. Forfas, 2010). However, it has been recognised that many of these reports have become outdated and need to take into account new and emerging information (Kopke and O’Mahony, 2011). There is also a recognition amongst other sectors (e.g. agriculture) of the need to adapt to both the positive and negative impacts of climate change (Desmond and Shine, 2013). Therefore, there is a need for sectors to expand their approaches through the incorporation of vulnerability and risk assessment, prioritisation, costing, identifying adaptation options, adaptation planning, the implementation of adaptation actions, and the evaluation and monitoring of these actions (Kopke and O'Mahony, 2011). The relatively short time frame (mid-2014) to produce an adaptation plan under the NCCAF (DECLG, 2012) has resulted in several sectors (i.e. the Office of Public Works (OPW), the Department of Agriculture, Food and the Marine) already expanding the scope of their adaptation strategies although there has been no central guidance offered with respect to the methodologies employed in doing so or how uniformity of process or outcome across the sectors might be achieved.

2.3 Review of Existing Climatic Information for Ireland

The detection of a climate change signal, the development of a clear understanding of the expected impacts of climate change and the ability of systems to respond are all required to plan for climate change adaptation. However, processes for the creation of climatic information are generally top–down rather than bottom–up, are supply driven and are generally shaped by the interests of the researchers and the limited data available to them rather than by analyses of user needs (Dinshaw et al., 2012). As a result, available climatic information and data can often be challenging for users to access, understand and apply. In addition, decisions about climate change need to be made at different spatial and temporal scales and, often, data and information from models, forecasts and other types of scientific data are not applicable at the scales relevant to adaptation decision making.

Shine and Desmond (2011) determined that there is now enough information available in Ireland to plan for the positive and negative impacts of climate change. This is confirmed by the wide variety of information currently available on a wide range of climate variables, projected changes in these, and a growing understanding of the expected impacts of climate change. A review of this information is included below.

2.3.1 Observed climatic information

There is an increased awareness of the impacts of climate change on society and that policy decisions must be based on an understanding of trends in climate and changing frequencies and intensities of extreme events. It is, therefore, considered useful and necessary to regularly examine trends in climate-related data and to establish whether patterns in global climate records are reflected in and comparable with local and regional records of change (McElwain and Sweeney, 2007). In addition, observed climatic information and data can be employed as analogues of how climate change impacts might manifest themselves in the future. For example, the 2003 summer heatwave in Europe provided an early insight into the possible environmental, societal and health impacts of extreme temperatures that could become the norm by the 2040s (Stott et al., 2004). These analogues are advantageous as they may be described in far greater temporal and spatial detail than might otherwise be possible (Wilby et al., 2009).

For Ireland, and as a first step in examining whether long-term changes in Ireland's climate have occurred, McElwain and Sweeney (2003) examined changes in temperature and precipitation at 14 synoptic stations situated throughout Ireland and also with reference to data collected at the Armagh Observatory. Their findings indicated an increase in mean temperature similar to those indicated globally. Following from this, McElwain and Sweeney (2007) updated this analysis and employed longer time series data and with a higher temporal resolution and confirmed the previous findings and identified a continuation of trends that were consistent with global observations of climatic warming. For Ireland's marine domain, and employing a variety of data sets from Ireland and elsewhere, Nolan et al. (2010) described the status and key regulators of Ireland's marine climate. While this analysis was considerable, it highlighted the brevity of some of the available information and suggests that we are poorly equipped to make conclusions about the extent of climate change effects in Irish waters (Nolan et al., 2010). The report does however confirm global patterns of increasing sea surface temperatures and suggests that further research is required to increase confidence in estimates of climate change impacts (SLR, ocean acidification, alteration of food webs and downstream effects on coastal communities) and to facilitate the preparation of adaptation and mitigation strategies. Most recently, by considering a wide range of current and historical data sets, Dwyer (2013) compiled a report on observed climatic changes for Ireland's atmospheric, oceanic, terrestrial and hydrological domains. This revealed that the majority of observed changes reported for Ireland were consistent with regional and global trends.

2.3.2 Projected climatic and impact information

2.3.2.1 Projected climate changes for Ireland

As detailed in Table 2.1, various methodologies have been employed to project the future climate of Ireland and the results obtained have increased confidence in the likely changes expected whilst also identifying areas that require further research (Fealy et al., 2008). However, these projections have been developed using different methodologies, models and scenarios and considerations of aerosols and different aspects of the carbon cycle. In addition, they have employed different time periods in terms of future simulations and also for the control periods from which future changes are calculated. This makes it difficult to compare and contrast the outputs from each report.

The first comprehensive approach to climate change assessment for Ireland was undertaken by McWilliams (1991), in which simple climate scenarios were prescribed for employment in the modelling of climate change impacts for Ireland. Following from this work, Sweeney et al. (2003) used statistically downscaled global climate data to project climate changes and the key sectoral impacts for Ireland for the periods 2041–2070 and 2061–2090. This study marked a significant enhancement in terms of our understanding of the key climatic changes that Ireland might face. The results obtained were, however, based on the output of a single General Circulation Model (GCM) and, therefore, any policy decisions based on this approach carry considerable risk. This was recognised by the authors and two subsequent studies, detailed under Sweeney et al. (2008) and McGrath and Lynch (2008), employed a wide range of climate models and these were deemed to be representative of the range of projected future climate (including uncertainties) relevant to informing impact projection (Murphy and Fealy, 2010). The former study employed statistically downscaled GCM data from a range of GCMs and for two emissions scenarios (A2 and B2) while the latter employed dynamically downscaled GCM data and using a variety of emissions scenarios (A1B, A2, B1, B2). For temperature, there is a consistency in the projections produced by Sweeney et al. (2008) and McGrath and Lynch (2008), both suggesting that temperatures will increase across all seasons and with the greatest changes projected for summer and winter. There is, however, some inconsistency in terms of spatial variations in this increase. Sweeney et al. (2008) suggest that temperatures will increase most strongly in the interior, while McGrath and Lynch (2008) suggest that increases will be strongest in the south and east of the country. For precipitation, differences in projected changes are apparent between Sweeney et al. (2008) and McGrath and

Table 2.1. Summary details of methods, models and scenarios employed in downscaled climate projections for Ireland. Details of temporal and spatial resolutions are also included.

Group	Approach	RCM	AOGCM	SRES	Period	Spatial resolution
Sweeney et al. (2003)	SDS	N/A	HadCM3	GGa1	2041–2070 2061–2090	10 km
Sweeney et al. (2008)	SDS	N/A	HadCM3 CGCM2 CSIRO Mk 2	A2 B2	2020–2080	N/A
McGrath and Lynch (2008)	DDS	RCA3	ECHAM 4/5 HadCM3L/3H	A1B A2 B1 B2	2021–2060/2100	14 & 25 km
Nolan et al. (2013a,b)	DDS	CLM3 CLM3 (1) & (2) CLM4 (1) & (2) WRF	EC-Earth HadGEM2 CGCM3.1 ECHAM5	RCP 4.5 RCP 8.5 A1B B1 B2	2021–2060	7, 6 & 4 km

RCM, Regional Circulation Model; AOGCM, Atmosphere Ocean General Circulation Model; SRES, Special Report on Emission Scenarios; SDS, statistical downscaling; DDS, dynamical downscaling.

Lynch (2008) and particularly for the middle of the century. The simulations produced by McGrath and Lynch (2008) project the greatest decreases in precipitation to occur in summer and along the west coast of Ireland, while those produced by Sweeney et al. (2008) suggest that the greatest decrease in precipitation will occur in summer but along the east and south coasts. Most recently, dynamic downscaling of a range of GCM has been undertaken for Ireland for the period 2021–2060 (Nolan et al., 2013a,b). These projections indicate an annual average increase in temperature, with the largest changes projected for summer and winter. For summer, the temperature gradient is from north-west to south-east, while for winter it is in direct contrast, with a south-west to north-east gradient (Nolan et al., 2013a). For precipitation, a slight decrease in annual average levels is apparent for the mid-century but, when examined seasonally, there are substantial changes projected with wetter winters, particularly in the west, and drier summers, particularly in the east (Nolan et al., 2013b).

2.3.2.2 Impact analysis

As detailed in Table 2.2, outputs from downscaled modelling experiments for Ireland have been employed in analysing the potential impacts of future climate change for Ireland. However, and similar to climate modelling experiments undertaken for Ireland, the projection of climate impacts have employed different time periods in terms of future simulations and also for the control periods from which future changes are calculated, and different methodologies, impact models and scenarios. This makes it difficult to compare and contrast the outputs from each study and outcomes can be dependent on the impact model employed. In addition, and in most instances, projected impact analyses have been undertaken for specific exposure units, e.g. catchments, and as a result, their applicability to other sites is limited. Nonetheless, the results indicate expected changes in climate impacts for Ireland and contribute to increasing confidence in the changes that are likely.

Using conceptual rainfall run-off models, future changes in river flow have been simulated for Ireland and for a number of specific Irish catchments (Charlton and Moore, 2003; Charlton et al., 2006; Steele-Dunne et al., 2008; Hall and Murphy, 2010; Bastola et al., 2011). Most recently, studies have begun to not only assess changes in the frequency and extent of flooding and drought but also the vulnerability of individual water supply systems (e.g. Hall and Murphy, 2010). Studies on the impact of climate change on Ireland's agriculture have employed climate projection data in conjunction with a variety of cropping models to evaluate changes in the spatial distributions of economically important crop types (Holden and Brereton, 2002; Holden et al., 2003). Following from these first-order impact assessments, the impacts of climate change on agricultural production systems have also been assessed (Holden et al., 2008). An analysis of changes in climatic zones for Ireland has been undertaken in order to assess potential changes in the distribution of biodiversity in Ireland (Byrne et al., 2003) and, more recently, climate projection data have been employed to model the potential future distribution of biodiversity and habitats under expected climate change (Sweeney et al., 2013). The analysis of impacts of SLR and changing frequencies and intensities of storm surges on the Irish coast has also been undertaken (Fealy, 2003; Lozano, 2004; Wang et al., 2008), while the potential for Ireland's future wind energy resource has also been examined (Nolan et al., 2012a,b). Recently, an examination of specific impacts of climate change on individual sectors including tourism (Tourism Climate Index) and construction (wind-driven rain and groundwater contamination) has been undertaken (Sweeney et al., 2013).

2.4 Comparison and Critical Review of Existing International CIPs

In order to inform the development of the prototype CIP, a comparative and critical review of existing national CIPs was undertaken. The eight online platforms (websites) selected (detailed in Table 2.3) were considered to provide a broad coverage of adaptation (EEA, 2013). In general, these focused on three key areas of information provision: awareness raising, information provision, and decision support, as considered below.

1. ***Awareness raising***

   As a first step in facilitating adaptation planning and overcoming the most common barriers to climate adaptation, such as a lack of awareness,

Table 2.2. Summary details of methods, models and spatial resolution of downscaled impact projections developed for Ireland and according to sector.

Sector	Parameter/Variable	Method	GCM/RCM	Impact model	Spatial resolution
Hydrology					
Charlton and Moore (2003)	Run-off	SDS	HadCM3	HYSIM	Gridded
Charlton et al. (2006)	Water supply & flood hazard	SDS	HadCM3	HYSIM	Gridded
Wang et al. (2006)	Discharge	DDS	ECHAM4 & 5	HBV	Individual catchment (Suir)
Murphy and Charlton (2008)	Hydrology	SDS	HadCM3	HYSIM	Individual catchments (Moy, Boyne, Ryewater, Barrow, Suir, Blackwater, Shannon)
Steele-Dunne et al. (2008)	Hydrology	DDS	ECHAM5 RCA 3	HBV	Individual catchments (Moy, Suck, Brosna, Boyne. Barrow, Suir, Blackwater, Feale, Bandon)
Hall and Murphy (2010)	Water supply	SDS	HadCM3 GCM2 CSIRO Mk 2	WEAP21	Moy
Bastola et al. (2011)	Flood frequency	SDS	GCMs (17)	HyMOD NAM TANK TOP	Individual catchments (4)
Hall et al. (2013)	Water supply – vulnerability	SDS	HadCM3 GCM2 CSIRO	HYSIM WEAP	Boyne
Sweeney et al. (2013)	Water supply – vulnerability	SDS	HadCM3 GCM2 CSIRO	HYSIM WEAP	Boyne, Glore
Agriculture					
Holden and Brereton (2002)	Crop yield (grass)	SDS	HadCM3	Johnstown Castle Grass Model	Gridded
Holden et al. (2003)	Crop yield (potato, barley)	SDS	HadCM3	CERES SUBSTOR	Gridded
Holden et al. (2008)	Agricultural production systems	SDS	HadCM3 CGCM2 CSIRO Mk 2	DSSAT	Selected sites
Biodiversity					
Byrne et al. (2003)	Climatic zones	SDS			Gridded
Sweeney et al. (2013)	Species & habitat	DDS	HadCM3 RCA3	Dispersal	Gridded
Coastal & Marine					
Fealy (2003)	Inundation				National
Lozano et al. (2004)	Storminess	DDS	ECHAM4 A-GCM	OAGCM	Europe
Wang et al. (2008)	Storm surge	DDS	ECHAM5/OM1	ROMS	Europe
Flood and Sweeney (2012)	Inundation				National

Table 2.2 *contd*

Sector	Parameter/Variable	Method	GCM/RCM	Impact model	Spatial resolution
Energy					
Nolan et al. (2012a)	Wind energy	DDS	ECHAM4/ ECHAM5	RCA3	National
Nolan et al. (2012b)	Wind energy	DDS	ECHAM5	COSMO-CLM	National
Construction					
Sweeney et al. (2013)	Wind-driven rain Septic water treatment	DDS	HadCM3 RCA3	Airfield index Septic tank density WFD	National (county)
Tourism					
Sweeney et al. (2013)	Tourism Climate Index (TCI)	SDS	HadCM3 GCM2 CSIRO	TCI	National

SDS, statistical downscaling; DDS, dynamical downscaling; GCM, General Circulation Model; RCM, Regional Circulation Model.

scepticism and denial, the majority of the platforms provided information specifically designed to raise awareness of climate change and adaptation. This awareness raising can be considered as a 'soft' adaptation measure (EEA, 2013) and was achieved in two ways:

(i) To make climatic and adaptation science understandable and overcome barriers such as scepticism, the majority of the sites provided information on climatic and adaptation science more generally. This information included details of, amongst others, climate change, climate modelling, adaptation, mitigation and other key climatic science concepts; and

(ii) To make climate change relevant, the majority of the sites presented examples of recently observed changes in climate and their associated impacts.

2. ***Information provision***

For the majority of the sites projected climatic change and impact data formed a key component, were presented both on-site and through external links (e.g. directing to the relevant national meteorological service), and by a number of means (text, tables and maps). For those sites that had developed climate information viewers, the information displayed was generally tailored to the needs of adaptation planning. For example, projected information on climatic changes was displayed according to spatial planning boundaries, e.g. at district level. In addition, information on projected climate change impacts was provided by some platforms and, for the most part, was tailored to the specific needs of the users, i.e. information was provided for key national impacts, e.g. projections of expected SLR were provided for Holland. Information on sectoral-specific impacts was also presented on the majority of the websites considered. However, this information was provided under a number of headings, including: Sectors, Sectoral Responsibility, Resources and Activities. Information provided included general information on, amongst others, key impacts or threats, opportunities and costs, best practice, adaptation options, surveys and studies and publications.

3. ***Decision support***

In order to facilitate adaptation planning, decision support formed a key component of many of the adaptation platforms. In general, the decision support provided consisted of frameworks/ assessments, which employed climatic data (historical, current and projected) to enable users to identify current and future vulnerability. In some cases, the tools provided were generic and provided information on incorporating adaptation into planning more generally (e.g. Norway), while others employed specific tools targeted at

Table 2.3. Summary table detailing findings from a review of existing International Climate Information Platforms (CIPs). Summary details are provided according to three criteria – awareness raising, information provision, and decision support.

Site	Awareness raising	Information provision	Decision support
Austria The Austrian Climate Portal (http://www.accc.gv.at/englisch/index.htm)	Information on climate science provided through a *Climate Basics* link that details the causes of climate change and its potential impacts. Information on adaptation, Regional Circulation Model (RCM), extreme events and sectoral-specific impacts for some sectors are provided on-site.	Climatic information provided through external links, while information on impacts for some selected sectors is provided on-site.	Information on current international and national climate policy is provided on-site.
Denmark Climate Change Adaptation (http://www.klimatilpasning.dk/)	Information on the expected future climate changes for Denmark is presented. Importantly, information provided is tailored to the needs of citizens, municipalities and businesses.	Projected climatic changes are illustrated for Denmark through an interactive map – *Climatemap*. The sectoral impacts of climate change are also described through a *Sectoral Resource Area*.	A range of tools is provided that focus on the identification of future vulnerabilities (e.g. *BusinessWizard, Climatemap, Climatemeter, Resilient House*).
Finland Climateguide.fi (http://ilmasto-opas.fi/en/)	A wide variety of materials is provided through the *Climate Change Explained* resource. This includes descriptions of observed changes in climate, the causes of climate change and expected climatic changes for Finland.	Observed and projected climate information is displayed through a dedicated on-site map viewer – *Observed and Projected Climate*.	Information on sectoral-specific solutions (mitigation & adaptation) is provided – *Community Response Wizard*.
Germany Climate Compass (http://climate-compass.net)	Provides some basic information and employs examples of current weather events to highlight possible future changes in the climate of Germany and expected impacts.	Information is predominately accessed through external links.	The *Climate Compass* resource can be considered a bottom–up adaptation tool/framework.
Norway (http://www.regjeringen.no/en/dep/md/kampanjer/engelsk-forside-for-klimatilpasning.html?id=539980)	A wide range of information is provided through an interactive *Climate Change Adaptation Guide*.	Projected climatic changes are presented for Norway on-site, on a municipal basis. A wide range of other information is delivered through links to reports and guidance.	A range of planning tools is made available to allow for an examination of the overall climate situation.
Sweden Swedish Portal for Climate Change Adaptation (http://www.klimatanpassning.se/)	A wide range of information is provided (e.g. how climate is changing and impacts; sectoral impacts).	Projected changes in climate are illustrated through an online map viewer maintained by the Swedish met service.	A wide variety of tools is provided both on-site and off-site – *Adaptation Tool, Natural Disaster Tool*.
Switzerland Klimaanpassung (http://www.bafu.admin.ch/klimaanpassung/index.html?lang=de)	Some detail on the sectoral impacts of climate change is provided, information is accessed primarily through links to reports.	Observed projected climatic changes are displayed through an on-site web-based viewer (viewable to a district level).	No decision support tools are provided.
UK UK Climate Impacts Programme (http://www.ukcip.org.uk/)	A wide variety of awareness-raising information is made available through the *New to Adaptation* resource.	Climate information is accessed through external links (UKCP09).	A wide range of tools is provided which are tailored towards particular user groups (e.g. *BACLIAT, LCLIP, Adaptation Wizard*).

particular areas (e.g. local authorities, private industry and small to medium-sized enterprises (SMEs) – Scotland). The United Kingdom Climate Impacts Programme (UKCIP) provided the widest range of tools for the general public, private business and government.

In order to aid adaptation planning, the inclusion legislation and regulation are important. However, the inclusion of relevant/associated legislative information varied greatly among the websites examined, with the majority considering legislative information on a national basis, although some also included detailed information on international climate policy. The inclusion of legislative information on a sectoral basis appeared to be determined by national requirements for planning. For example, the Scottish platform details relevant flooding guidelines, e.g. Flood Risk Management (Scotland) Act 2009, in the water management sector link, while the Norwegian platform dealt with legislation and regulations extensively as the incorporation of adaptation into regional planning is required by law.

2.5 Direct Stakeholder Engagement

The first phase of the ICIP project aimed to tailor existing and relevant climatic and adaptation information and data to the needs of the key user groups in planning for climate adaptation, deliver this information through the prototype CIP, and to act as a bridging organisation between data providers and users in order to best serve the needs of the user groups and make best use of available information and data (Fig. 2.2). As a result, the engagement of these groups formed an integral part of both developing a vision for, and delivering, the prototype CIP itself.

In establishing a vision for development for the prototype CIP, two key workshops were held, involving expert users and data providers. An initial consultation workshop entitled *Assessing the Information Required for Climate Change Adaptation Planning* was held with sectoral experts in Dublin on 9 May 2012 and sought to identify the information required to plan for adaptation to climate change by a number of important Irish sectors. This workshop was complemented by a second entitled *Ireland's Climate Information Platform (ICIP) – Employing available downscaled climate projection data for Ireland*, which was held with the key data providers in Dublin on 9 July 2012, with the purpose of garnering expert feedback and advice on

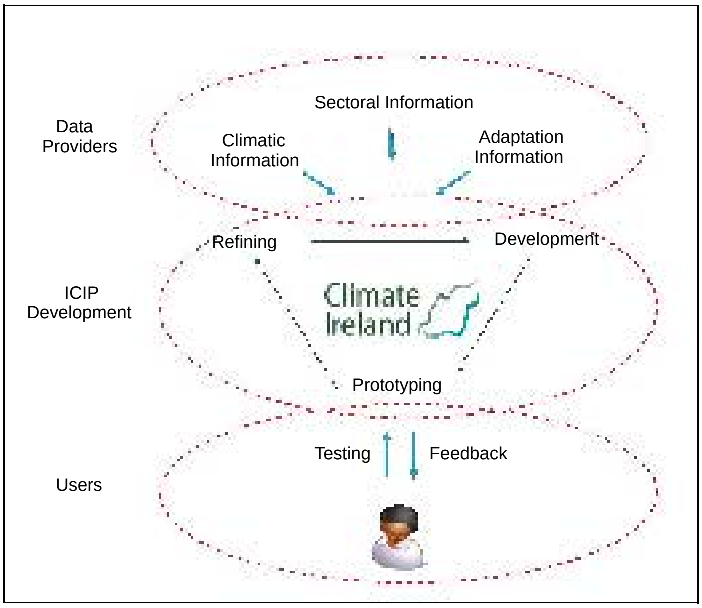

Figure 2.2. Schematic diagram illustrating the bridging role played by Ireland's Climate Information Platform (ICIP) between data providers and users.

the employment of available downscaled climate projection data for Ireland. This process was augmented by several formal and informal meetings with the key data providers to establish access to key and raw data holdings and to assess the potential for inclusion of same in the prototype CIP.

2.5.1 Expert User Workshop

Expert opinion is considered a useful method of obtaining a rapid assessment of the state of knowledge concerning the effects of climate change on a given exposure unit (IPCC, 1994). This workshop (*Assessing the Information Required for Climate Change Adaptation Planning*) brought together a number of important sectors of the Irish economy (Agriculture and Forestry; Biodiversity; Coastal, Marine and Fisheries; Critical Infrastructure; Tourism and Cultural Heritage; and Water Management) to discuss collectively their information requirements with respect to planning for adaptation.

In order to set the scene, the workshop started with a series of presentations examining climate change implications for Ireland and current approaches to adaptation decision making. Following these presentations, a questionnaire survey was distributed to, and completed by, all participants to gather information on sectoral concerns relating to current and projected climates, the significance of current and projected climate variability and extremes to sectoral planning, and the employment of climatic information and data in this planning. Participants subsequently participated in three interlinked breakout sessions organised on a sectoral basis with workshop attendees assigned to sectors most relevant to their respective backgrounds and expertise. As illustrated in Fig. 2.3, the first breakout session examined the projected impacts of climate change on sectoral operations, the second considered current sectoral planning practices and the third discussed the information required to allow sectoral planning for adaptation to the projected impacts of climate change.

The primary outcomes from the workshop were that participants confirmed that all the sectors considered are concerned about the impacts of climate change and were aware of the projected impacts of climate change on their respective sector. Key concerns include:

- Increased risk of coastal and river flooding;
- Increasing temperatures;
- Decreased levels of summer precipitation;
- The increased frequency of heat waves; and
- Extreme weather events.

There was general recognition among participants of the availability of information and data to support

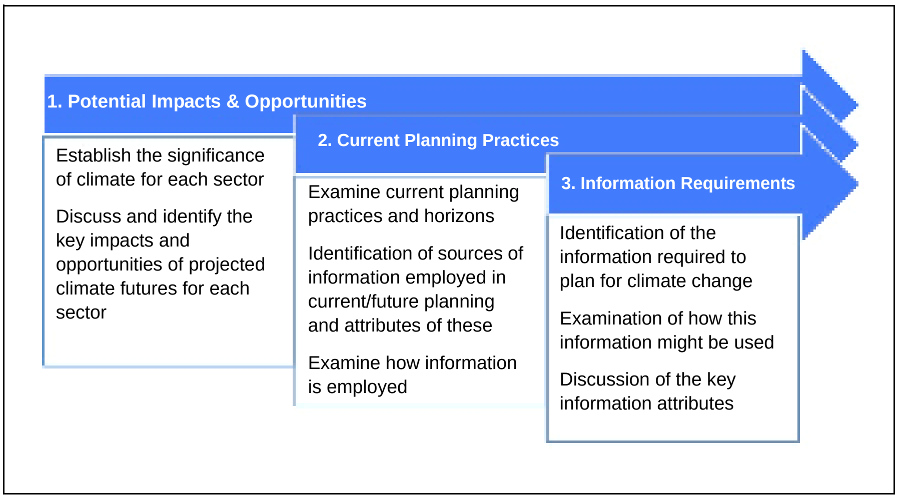

Figure 2.3. Summary diagram detailing the aims of the three breakout sessions undertaken as part of the Expert User Workshop – *Assessing the Information Required for Climate Change Adaptation Planning*.

Plate 2.1. Photograph of breakout sessions held as part of the Ireland's Climate Information Platform (ICIP) workshop *Assessing the Information Required for Climate Change Adaptation Planning*.

planning for climate change. However, for the most part, due to relatively short-term planning horizons and the differing aims of current planning practices (e.g. meeting EU requirements), existing planning practices were not deemed adequate in terms of underpinning the development of any adaptation plan or strategy.

Information identified by participants as being required for sectoral planning for adaptation to climate change included projected changes in climatic variables and information concerning specific sectoral assets/ attributes that are thought to be affected by climatic change. For projected climate change, key information included SLR, waves and surges, temperatures, precipitation, ground and surface water run-off and phenology. Information required for sectoral assets/ attributes included, amongst others, location data for infrastructure/ecosystem services, existing design and tolerance data for coastal infrastructure, and soil and land-cover data. In combination, this information would be used primarily for undertaking risk assessment for current assets and in planning for future development. In addition, and importantly, information elicited through this workshop has identified areas where baseline information for planning for climatic change is currently lacking.

2.5.2 Data Provider Workshop

The prototype CIP has the specific aim of facilitating sectoral and regional planners in employing climatic information and data in their adaptation planning. However, simply making more locally specific information about climate change impacts available has been shown not to be effective in motivating appropriate actions (Demeritt and Langdon, 2004). The lack of accessibility to user-friendly climatic information has also been identified as a key barrier to adaptation both nationally (Falaleeva et al., 2013) and for Europe (Hanger et al., 2013). Consequently, the prototype CIP aims to provide climate information in a form that is accessible, and of use, to users. In order to develop the best options for employing existing downscaled climate projection data for Ireland, a workshop was held with the key climate data providers to garner expert feedback and advice on the employment of available downscaled climate projection data for Ireland. This workshop aimed to address a number of key issues regarding the employment of available and downscaled climate projection data for Ireland.

1. **Integration of available climate projection data**
   As described previously, a range of climate projection data currently exists for Ireland (McGrath and Lynch, 2008; Sweeney et al., 2008; Nolan et al., 2013a,b) and this has been determined as being adequate to begin the process of adaptation planning (Shine and Desmond, 2011). However, these projections were the result of a variety of modelling efforts, employing different models (GCM and Regional Circulation Models (RCMs)), scenarios and time periods and therefore are difficult to compare (not standard). Nonetheless, and as agreed by all workshop attendees, existing climate projections can be considered as advantageous as they provide for a range of plausible futures/ensembles

of projected climate changes and should be employed within the prototype CIP.

2. **Standardisation of existing climate projection data**
   Currently, existing climate projection data for Ireland have been developed at a variety of temporal and spatial scales. In order to allow for comparison of individual climate projections and for employment of the full ensemble of projections, it was agreed that existing climate projection data should be standardised on a spatial and temporal basis.

3. **Development of data for employment in adaptation planning**
   Development of climate projection data for incorporation in the prototype CIP requires the development of the data for employment in adaptation planning. Uncertainty forms a key barrier to the employment of climate projection data by decision makers and, as a result, it was thought essential that the prototype CIP attempts to address this issue. It was agreed that as a first step in dealing with issues of uncertainty in model prediction, the prototype CIP should allow users to examine the full range of climate projection data and inter-model difference in projection. This allows for the evaluation of the full range of potential future changes and on this basis serves to enhance the quality and robustness of decisions taken. Robustness to uncertainty is one of the key indicators of the effectiveness of an adaptation action, along with the ability and flexibility to change (Adger et al., 2005).

2.6 Vision for Development

Currently, Ireland can be considered to be at the early stages of the adaptation planning process. Until recently, climate adaptation has not been considered a high priority for decision makers in Ireland. This was due to a lack of a statutory requirement to address climate adaptation concerns and also due to a lack of awareness amongst decision makers and the public more generally. However, the recently published NCCAF (DECLG, 2012) provides a (albeit non-statutory) mandate for planners and administrators at sectoral and local authority levels to begin the process of adapting to climate change. Whilst a degree of ambiguity surrounds the current status of any adaptation plans and strategies resulting from this work, it is likely that future legislation will seek to legitimise adaptation as a central aim of local and sectoral planning.

The development and delivery of the prototype CIP aims to facilitate decision makers in Ireland to begin the process of adaptation through increasing understanding and subsequently transitioning decision makers through the planning and management phases of the adaptation process. More specifically, as outlined below and in the context of an idealised adaptation cycle, the prototype CIP aimed to address three key areas of information provision to facilitate decision makers in undertaking the process of adaptation planning (Fig. 2.4):

1. Awareness Raising and Understanding;
2. Provision of Climate Information; and
3. Decision Support

From the above, the key barriers to initiating and supporting adaptation were identified as the lack of:

1. Awareness and understanding;
2. Tailored, locally applicable data; and
3. Tools that enable use of climate change data.

Therefore the vision of the prototype CIP was to:

- Increase understanding of climate change and adaptation by providing decision makers with the information they require to interpret and assess how the effects of global climate change might impact upon their areas of operation and further how the adaptation process can be employed to enable planning for adaptation to these impacts;
- Assemble, integrate and tailor climatic, impact and risk information for employment by decision makers in planning for climate change. This will allow for an increased understanding of expected climate change impacts and for the (re)definition of the climate change problem for a specific location/sector of operation; and

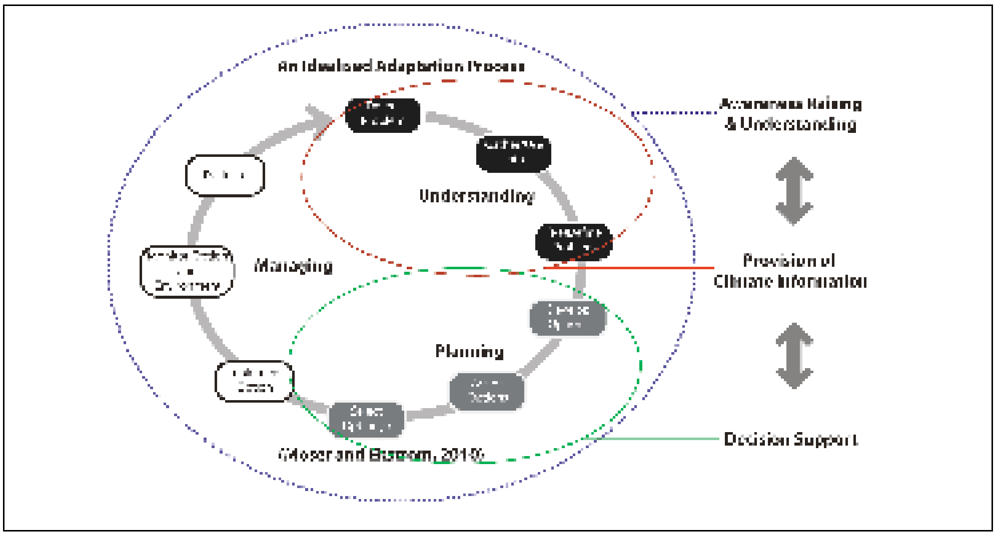

Figure 2.4. Diagram illustrating the three areas of informational provision and support (Awareness Raising and Understanding, Provision of Climate Information and Decision Support) identified as being required to initiate and plan for climate adaptation in Ireland and in the context of an idealised adaptation process.

- Develop a set of tools to allow decision makers to employ the information made available through the prototype CIP in their planning. These tools would be designed to facilitate Ireland's decision makers in transitioning from the understanding phase of the adaptation planning cycle to the planning and managing phases and in meeting the requirements of the NCCAF (DECLG, 2012). This is because it is now essential that decision makers begin to employ climate information and data in developing their adaptation strategies and incorporate these strategies into their existing planning practices.

3 Delivering a Prototype CIP

As part of the visioning exercise (see Chapter 2), three key areas of information provision and support were identified as being required to facilitate the initiation and progression of climate adaptation in Ireland:

1. The provision of information on climate change and adaptation to increase awareness and understanding of same;

2. The integration, tailoring and provision of existing climatic, impact and risk information for Ireland to allow decision makers to redefine the problem of climate change for the area; and

3. The provision of decision support tools to facilitate decision makers in employing climatic information and data in their planning for climate change adaptation.

The delivery of the prototype CIP was predicated on the development of a web-enabled information system, the *Climate Ireland* resource (http://www.climateireland.ie), which is both flexible and expandable and thus meets the requirements of both the data providers and the decision makers. As such, it will be able to readily accommodate new and updated climate projection data as and when these data become available, and it will be portable and readily transferable where and when required.

3.1 Awareness Raising and Understanding

There are significant issues in this area (see Chapter 2 for details) and as a result, the prototype CIP aims to:

- Provide materials to develop and improve users' understanding of climatic and adaptation science;

- Develop an understanding amongst users of the uncertainties inherent in projecting future climate and its impacts; and

- Enable users to develop an understanding of how, by adopting a variety of management approaches (e.g. adaptive management, robust decision making), adaptation can be implemented despite this uncertainty.

Information on climatic science is provided through the climate change section of the *Climate Ireland* resource. This defines climate by identifying the differences between climate and weather, describes the mechanisms that have resulted in the anthropogenic forcing of climate, subsequent and expected climatic changes and potential impacts, and clarifies the distinction between direct and indirect impacts. Following from this, scientific evidence for observed changes in climate is provided on both a global and a national basis and the motives for adaptation outlined. This is augmented by a summary of observed evidence for climate change, as reported by Dwyer (2013). The process of modelling future climate is then described and the various sources of uncertainty in developing downscaled climate projections explained. Following from this, global and national-level projections of climate change are summarised.

Information on adaptation science is provided through the adaptation section of the *Climate Ireland* resource. This first defines and describes adaptation, differentiates between mitigation and adaptation, and describes the variety of adaptation responses available to decision makers. This is followed by a description of issues of uncertainty and the means by which adaptation can address these uncertainties, e.g. adaptive management and robust decision making. Adaptation policy, both international and national (e.g. the NCCAF (DECLG, 2012)), is also described and a framework for managing adaptation outlined.

3.2 Information Provision

Information on the expected impacts of climate change is delivered through three tools:

1. The *Climate Information Tool*;

2. The *Climate Hazard Scoping Tool*; and

3. The *Sectoral Adaptation Information Tool*.

The *Climate Information Tool* provides decision makers with a one-stop resource of downscaled climate change projections for Ireland, the *Climate Hazard Scoping Tool* facilitates decision makers in examining their exposure to key expected climate change impacts, while the *Sectoral Adaptation Information Tool* provides sectoral-specific climatic and adaptation information.

3.2.1 Climate Information Tool

In order to initiate, plan for and manage climate adaptation, decision makers now require information on how human-induced warming may affect key climatic parameters, such as precipitation and temperature, and the effects these changes will have on their region of interest (IPCC, 2012). As detailed in Section 2.3.2, a wide range of climatic information currently exists for Ireland. However, these projections, which have been produced using different techniques, models and scenarios, are available in a variety of formats and with differing means of access. As a result, decision makers face a number of challenges in accessing and employing this information. For example, at a European level, decision makers did not see a lack of information as a barrier but rather wished for better accessibility and user friendliness of existing data (Hanger et al., 2013). Moreover, for decision makers working in Irish coastal communities, accessibility of information was identified as a key barrier to the incorporation of climatic information and data into planning (Falaleeva et al., 2013). As a result, in order to provide decision makers with a robust understanding of expected climatic changes for Ireland and to enable decision makers to make best use of available climatic information and data, a key part of development involved the collation, standardisation and integration of existing climate projection data into a single application.

The *Climate Information Tool* allows decision makers to access and query the range of downscaled and projected climatic data for Ireland[1] and overcomes issues of differences in the spatial and temporal resolution of these projections (Fig. 3.1). Temporally, projected climatic data are displayed at a decadal resolution, a period that is long enough to filter out any inter-annual variation or anomalies but yet short

1. Currently, climate projection data produced by Sweeney et al. (2008) and Nolan et al. (2013a,b) are available through the *Climate Information Tool.*

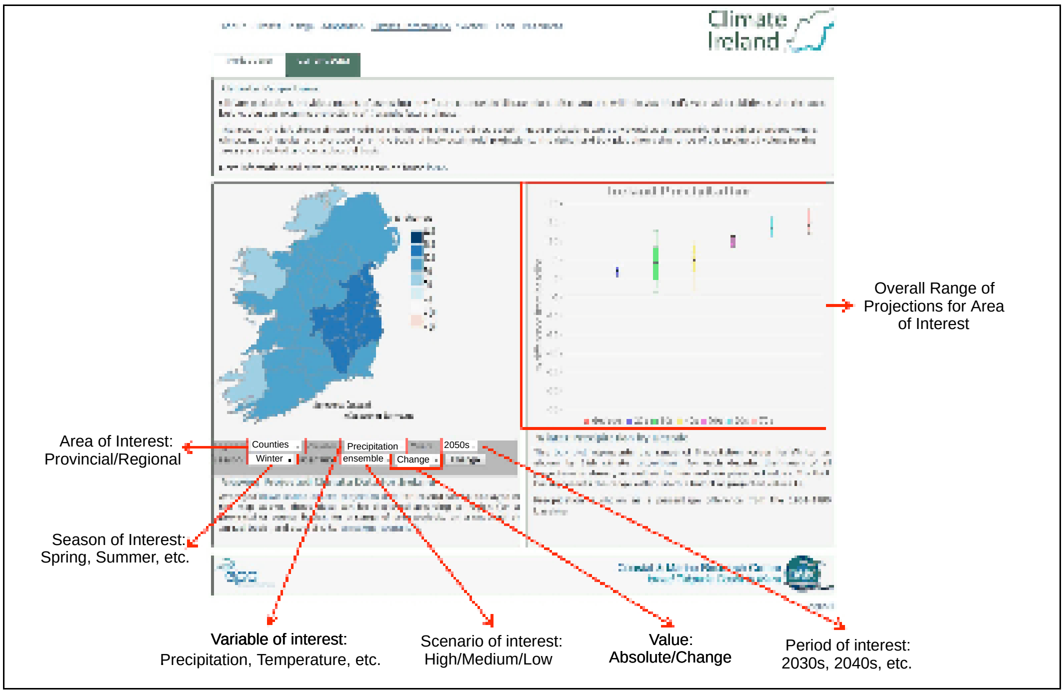

Figure 3.1. Example of the prototype Climate Information Platform (CIP) *Climate Information Tool* with the variety of options for users to query data indicated.

enough to reveal longer climatic trends (IPCC, 2007). Spatially, climate projection data are projected on a provincial and county basis, the spatial extent that corresponds with areas of local government in Ireland.

3.2.2 Climate Hazard Scoping Tool

Exposure to climatic stresses is a key determinant of a system's/area's vulnerability to climate change impacts (Fig. 3.2). Vulnerability (physical or social) to climate change determines the potential impact on a given system and is determined by a system's exposure and sensitivity to climatic stresses and adaptive capacity (or ability to adapt), which is determined by available economic resources, availability and access to technology (e.g. warning systems), information and skills, social infrastructure and institutions. In order to determine current and future levels of vulnerability, an understanding of levels of exposure to climate stresses is required.

The *Climate Hazard Scoping Tool* (Fig. 3.3) aims to facilitate decision makers in examining their current and potential future exposure to climate hazards. For each impact[2], the aim of the tool is to make best use of available information for Ireland in order to facilitate decision makers in determining their location-specific exposure to the projected impacts of climate change. Importantly, this tool describes and illustrates uncertainties relating to projected changes in exposure to hazards. Employing available information and data, both spatial and non-spatial, this is achieved through the provision of:

- A description of the climatic hazard under examination;
- A description of current levels of exposure to the climatic hazard using current and historical observational information and data, both spatial and non-spatial; and
- An assessment of how exposure to these hazards might change (spatially and temporally)

2. To date, impacts examined include coastal flooding, coastal erosion, inland flooding, water scarcity and loss of biodiversity.

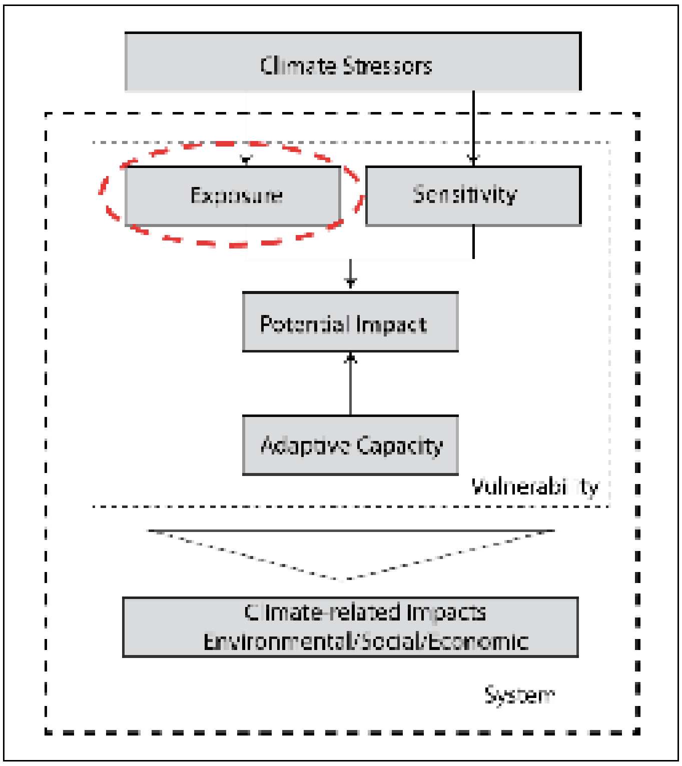

Figure 3.2. Diagram illustrating the factors that contribute to a system's level of vulnerability (sensitivity, exposure and adaptive capacity). The *Climate Hazard Scoping Tool* aims to facilitate users in determining their current and future levels of exposure.

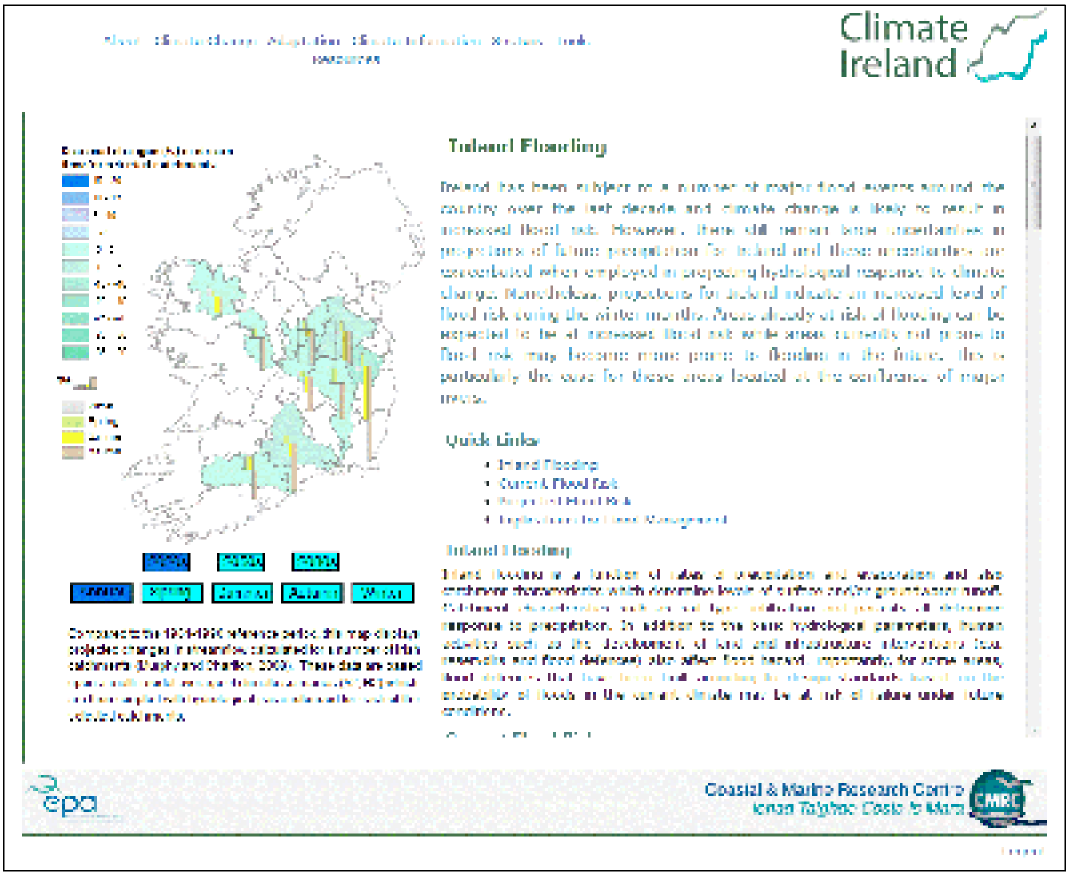

Figure 3.3. An example of the prototype Climate Information Platform's (CIP's) *Climate Hazard Scoping Tool.*

in the future by employing available projected climatic change and impact analyses.

3.2.3 Sectoral Adaptation Information Tool

For the key sectors of the Irish economy[3], climate change will result in a range of different challenges, with varying opportunities, and planning for climate change adaptation on a sectoral basis forms a requirement of the NCCAF (DECLG, 2012). As a result, a *Sectoral Adaptation Information Tool* (Fig. 3.4) has been developed, which aims to facilitate decision makers in coming to an understanding of what climate change might mean for their sector of operation and how they might begin to plan for adaptation. However, when employing this tool, it is important that users also consider cross-sectoral dependencies – for example the link between agricultural impacts and water management.

Drawing on a wide range of national and international information and data (spatial and non-spatial), the *Sectoral Adaptation Information Tool* facilitates decision makers in coming to an understanding of how climate change might affect their sector of operation and how they might adapt to these changes. In order to increase understanding of the effects of climate on sectoral operations and for each of the sectors examined, a description of the individual sector and its current sensitivity to climatic variability and extremes is first provided. A description of the sectoral-specific impacts and opportunities presented by climate change is also provided and a variety of adaptation options described. This is complemented by a list of additional informational resources.

3. The *Sectoral Adaptation Information Tool* currently examines the following sectors: Agriculture, Forestry, Biodiversity, Coastal Areas, Marine and Fisheries, Critical Information, Tourism and Cultural Heritage, and Water Management.

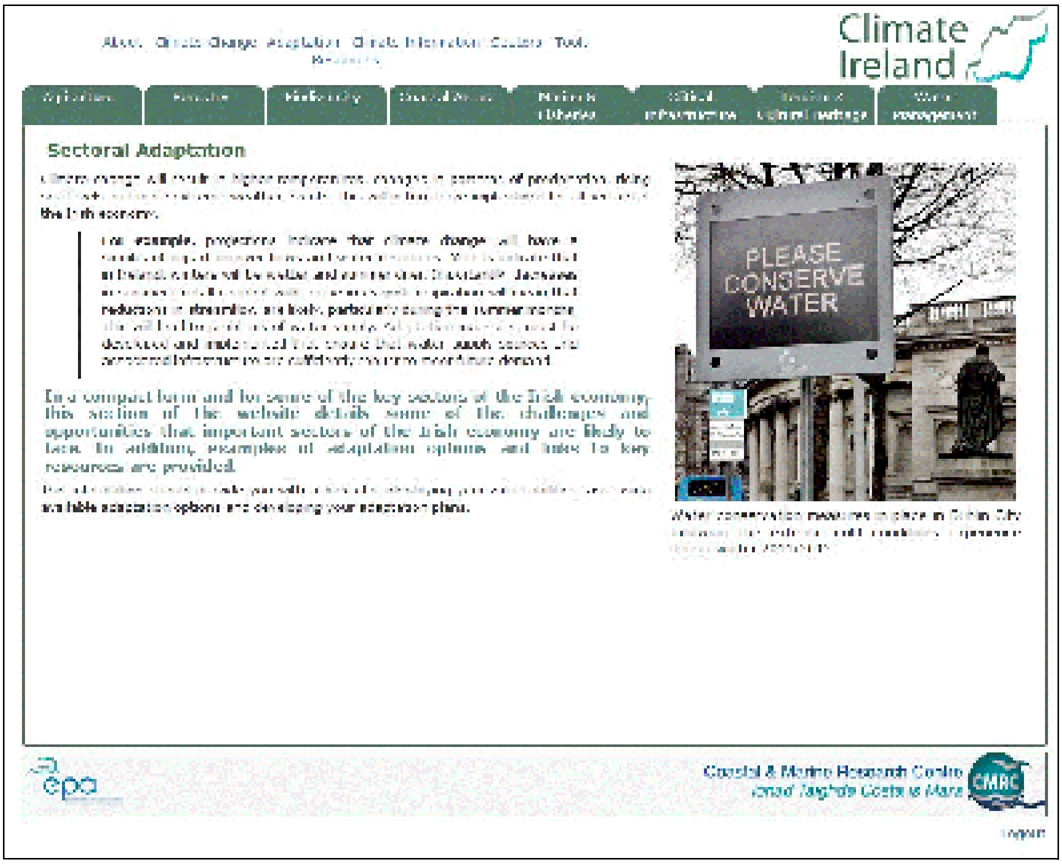

Figure 3.4. A screenshot of the prototype Climate Information Platform's (CIP's) *Sectoral Adaptation Tool.*

3.3 Decision Support

Adapting to climate change is a highly complex undertaking for decision makers at all levels of government, but particularly those at the local scale. While adaptation policy is developed at the national level (e.g. DECLG, 2012), local differences in physical environment, land use and population make the task of implementing adaptation principally the concern of regional and local-scale administrators. In order to transition Ireland from the understanding phase of the adaptation cycle through to planning and management phases, the prototype CIP aims to provide users with decision support tools to facilitate them in making best use of the information made available through the prototype CIP in initiating and planning for adaptation to climate change.

Until recently, the science-first approach predominated in adaptation planning, under which a relatively linear conception of climate impact projections in turn spurring adaptation action was the norm. The science-first approach typically began with an assessment of climate change on a location, the impacts of change on a particular system/s (e.g. hydrological system) and an exploration of the economic and non-economic costs of implementing adaptation measures. These approaches were particularly affected by the ballooning of uncertainties and relied on the ability of climate and impact models to generate high-quality information that could be meaningfully deployed in adaptation planning. Decisions would therefore be based on optimisation against a range of probability distributions and, as a result, under situations of ambiguity, the decisions arrived at were typically overly sensitive to uncertainty. As a result of these shortcomings, a policy-first approach is gaining traction in guiding adaptation planning, e.g. NCCAF (DECLG, 2012). This advocates starting at the scale of the adaptation problem – first specifying objectives and constraints and assessing current vulnerability – and, then, employing available climate projection data, characterising future climate risks and developing a strategy capable of perpetuating an adaptation process as one of continuous improvement and learning.

3.3.1 Adaptation Support Tool

ICIP’s *Adaptation Support Tool* is aimed at a wide range of users (e.g. decision makers, business, the general public) and aims to allow users to take full advantage of and integrate the different information made available through the *Climate Ireland* resource as part of the development of their adaptation plans. Development of the tool is based upon findings gained from communications with the key stakeholder groups (data providers and users), available and existing international climate adaptation tools (e.g. the UKCIP *Adaptation Wizard* and the EU Climate-Adapt *Adaptation Support Tool*), and adaptation frameworks proposed by Ranger et al. (2010), Stocker et al. (2012) and the EEA (2013).

The tool involves six stages[4], detailed in the following sections, and facilitates users through the adaptation planning process from identifying their area of planning and the key stakeholders involved to developing and implementing an adaptation plan (Fig. 3.5). The tool adopts a participatory mapping approach which functions as a vehicle for stakeholder deliberation and engagement (Stocker et al., 2012). In order to help users overcome the uncertainties in climate projection 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 context (Ranger et al., 2010). In contrast to the science-first approach, where detailed climatic projection data are a prerequisite to assessing vulnerability, users are encouraged to first undertake a broad assessment of the current and likely future sensitivity of the system they manage. This is achieved using a sensitivity analysis, which involves a rapid vulnerability assessment that allows for an exploration of climate sensitivity with stakeholders – a learning-by-doing approach. By examining and discussing the importance of relevant climate variables, stakeholders can consider the adaptation policies, programmes and procedures they currently employ, the important thresholds or criteria they use in management and how the relevant climate variables associated with these thresholds or criteria might change under projected climate change (Jones and Boer, 2004), and the nature of the effects. Detailed quantitative climatic data are *not required* for this assessment and high-level, broad-brush qualitative information on projected climate changes is sufficient. On this basis, and in combination with an understanding of current and historical vulnerability, decision makers can begin to identify the extent to which the opportunities and risks presented by climate change are important to their location and system of interest. This broad-scale

4. Stages 4 and 5 of the *Adaptation Support Tool* are still in development.

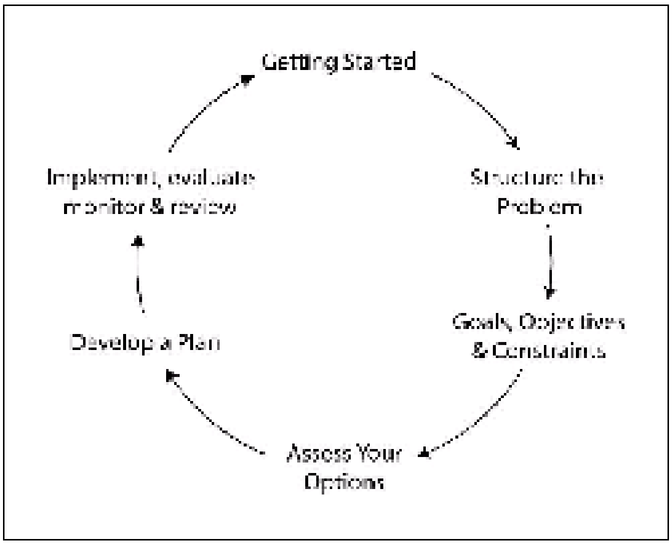

Figure 3.5. The *Adaptation Support Tool* framework.

assessment of future sensitivities also allows decision makers to identify where adaptation might be required in the future, where more detailed climatic and other information might be required and what measures are available to them.

Stage 1 (Getting Started)

Stage 1 of the process involves three tasks:

1. **Determination of the boundaries of the geographical area or community and**
2. **Identification of relevant stakeholders**

   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 and the stakeholders to be included in the project team (Stocker et al., 2012). In addition, it is also important to identify dependencies that are situated external to the area or community under investigation, e.g. transport system dependencies.

   For each community, there will likely be a wide range of stakeholders and the identification and engagement of all relevant stakeholders is a crucial step in developing an adaptation plan. This is because engagement generally improves the likelihood of anticipated outcomes from decision making (Gardner et al., 2009). This is an important step as adaptation is highly contextualised and no single adaptation approach will work with every community as the adaptation required will vary markedly between different stakeholder groups. In addition, adaptation will in some cases require substantial changes in local practices and these have a better chance of success if they originate in a process that involves engagement.

3. **Determination of motivations, objectives and constraints**

   When starting out on the process of adaptation, it is important that users identify their motivations for planning for climate change adaptation. This will allow for a consideration of the scope and level of analysis required (would a broad strategic view be most appropriate or would a more detailed assessment of one aspect of activity be more appropriate) and the identification of what information might be needed by whom and more importantly, why.

   There are many different motivations for planning for climate adaptation and these include curiosity, awareness raising, exposure to a recent extreme weather event, concern about property or community business or infrastructure, the need to make decisions with long-term consequences for land use, built assets or population groups and the identification of new opportunities.

   Once users have identified their motivations, the identification of what is to be achieved through the adaptation process (objectives) is important. To do this, users must identify the problem that they are faced with, what is intended to be achieved through the adaptation process, and how the success/failure in meeting these objectives will be assessed. In addition, at this stage of the analysis, it is also important for decision makers to identify any constraints that they might face.

Stage 2 (Structure the Problem)

Stage 2 involves four tasks:

1. **Participatory mapping of current exposure**

   This initial step allows users to come to a collaborative understanding of those areas that are currently exposed to the impacts of climatic and weather events (Fig. 3.6). This will provide the user with important insight into how their area has been impacted upon previously, which will help the user scope how future climate change might affect their area. This is because climate change is expected to exacerbate existing vulnerabilities and those locations currently most affected by weather-related factors are also likely to be those most impacted upon by climate change. It is also thought that adaptation to short-term climate variability and extreme events will reduce vulnerability to longer-term climatic change (IPCC, 2012).

   Employing a participative approach, previous weather events that impacted upon the user's area in the recent past (e.g. within the last 10 years) are identified. Following from this, and

Figure 3.6. An example of a participatory mapping exercise to an identify area under investigation (Map data©2014 Google, SIO, NOAA, US Navy, NGA, GEBCO). This mapping can be done by employing a wide range of means including electronic and paper-based maps.

employing the map generated through Step 1, for each event identified, those areas exposed are delineated, the key activities and resources identified, and the relevant climate variables (increasing average temperature; temperature extreme; extreme rainfall; drought; fluvial, pluvial and coastal flooding; rising sea level; storm surge; increasing ocean temperatures; changing ocean chemistry; extreme winds) determined (Fig. 3.7). In addition, and for each weather event, the identification of impacts that happened external to but had implications for the area under investigation (e.g. disruption of transport infrastructure or power supply) should be identified.

The identified variables and activities/resources are used to populate the vulnerability matrix provided through the *Climate Ireland* resource as rows and columns, respectively (Fig. 3.8).

2. **Assessment of current levels of vulnerability**
For those key activities and resources impacted upon, a qualitative approach is adopted to identify current levels of vulnerability. This involves ranking each of the identified activities and resources according to level of exposure, sensitivity and adaptive capacity. In the first instance, this can be achieved using qualitative measures such as low, medium, and high scores (1–3) (Fig. 3.8). On this basis, a vulnerability score will be calculated based on each of the resources or activities under consideration (Fig. 3.9).

3. **Assessment of expected future and unadapted vulnerability**
Based on an analysis of current levels of

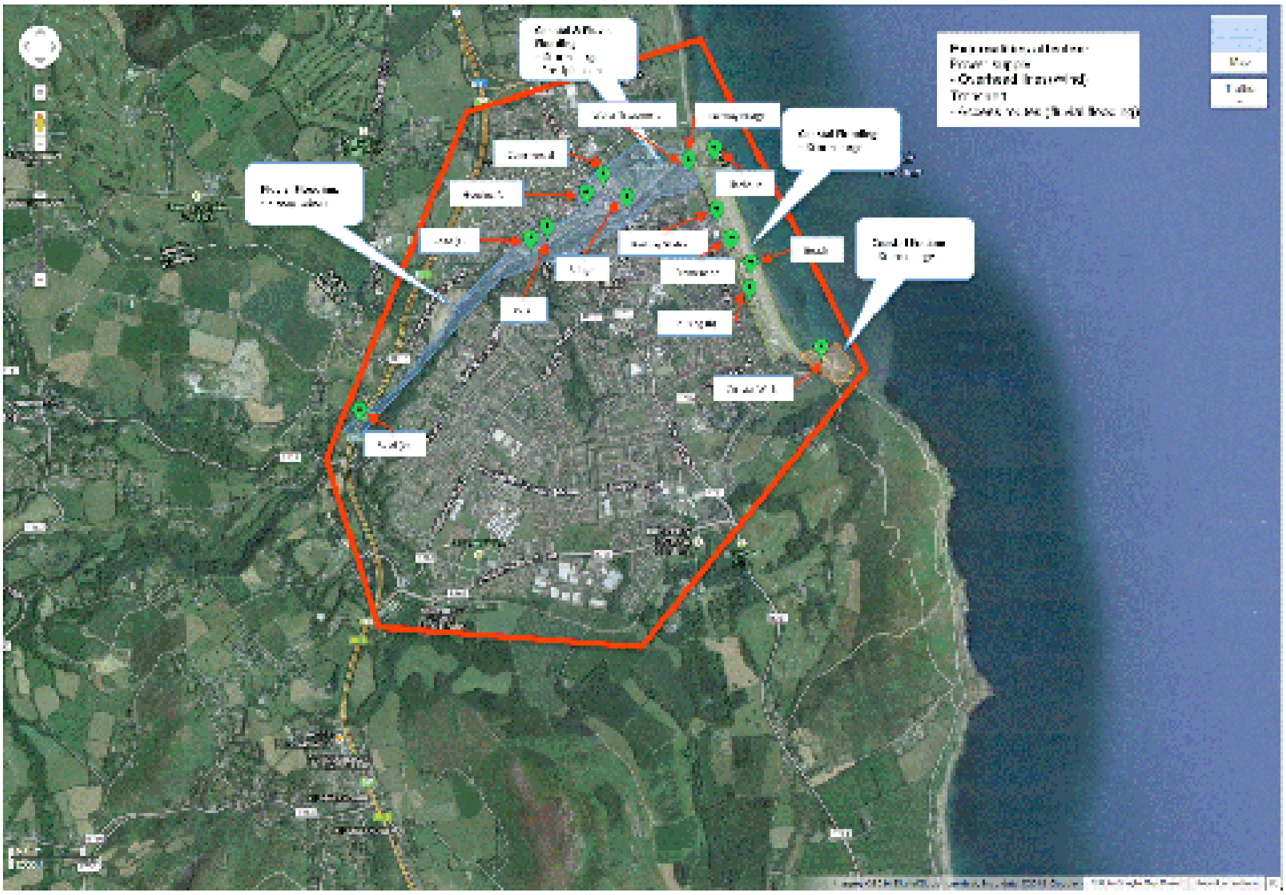

Figure 3.7. An example of a participatory mapping exercise to identify areas currently considered vulnerable to climatic variability and extremes (Map data©2014 Google, SIO, NOAA, US Navy, NGA, GEBCO).

vulnerability and the particular climatic changes that the area of interest is thought to be subject to, a qualitative assessment is made of how expected climate change might increase/decrease current levels of vulnerability. This is achieved by forcing the vulnerability matrix with scenarios of climatic change and more specifically by changing the levels of exposure attributed to each climatic variable (Fig. 3.10). This allows decision makers to develop a better understanding of possible future vulnerability to climate change by identifying resources/activities considered to be particularly vulnerable to expected future climate change or those climatic changes that are of particular importance to the location they are considering.

4. ***Characterisation of potential future exposure***

Once an understanding of potential future vulnerability is established, decision makers are then tasked with characterising how these increases/decreases in vulnerability might affect the resources and activities that are considered to be of importance within their area of interest. This is achieved through an examination of the maps created as part of Stages 1 and 2 and an assessment of how the effects of climatic changes on levels of vulnerability, identified in the previous task, might manifest themselves.

Stage 3 (Goals, Objectives & Constraints)

Once an understanding has been developed of how the future impacts of climate change might manifest themselves, decision makers are then tasked with prioritising potential impacts according to their motivations for planning for climate adaptation and the specific objectives identified through Step 1. This prioritisation can be based upon, amongst others, a

			Internal Resources/Activities												External Activities/Resources	
			Beach	Harbour	Coastal Walk	Promenade	Railway Station	Railway Bridge	Water Treatment	Park	Commercial	Housing (a)	Road (a)	Road (b)	Power Supply	Transport
Precipitation	Extreme	EXP.					3	3	3	3	3	3	3	3		3
		SENS					2	1	2	1	2	2	2	2		2
		ACAP					1	1	1	1	1	1	1	1		2
Fluvial	Flooding	EXP.						1	3	1	2	3	1	3		
		ACAP						2	3	2	3	3	2	2		
		SENS						1	1	1	1	2	1	1		
Sea	Sea level	EXP	3	3	2	3										
		SENS	3	3	2	3										
		ACAP	1	1	1	1										
	Storm surge	EXP	3	3	2	3			2							
		SENS	3	3	2	3			3							
		SENS	1	1	1	1			1							
	Coastal Erosion	Exp.	3	3	3	3										
		Sens.	3	2	2	3										
		ACAP	1	1	1	1										
Wind	Extreme	EXP.	3	3	3	3									3	
		SENS	2	2	1	2									3	
		ACAP	1	1	1	1									2	

Figure 3.8. Vulnerability Matrix – Users employ this matrix to rank resources and activities against identified climatic variables and according to level of exposure (EXP.), sensitivity (SENS) and adaptive capacity (ACAP).

			Internal Activities/Resources												External Activities/Resources	
			Beach	Harbour	Coastal Walk	Promenade	Railway Station	Railway Bridge	Water Treatment	Park	Commercial	Housing (a)	Road (a)	Road (b)	Power Supply	Transport
Precipitation	Extreme	Vul.					5	2	5	2	5	5	5	5		4
Fluvial	Flooding	Vul.						5	8	5	5	7	5	5		
Sea	Sea level	Vul.	6	8	3	6										
	Storm surge	Vul.	6	8	3	6			5							
	Erosion	Vul.	6	5	5	6										
Wind	Extreme	Vul.	5	5	2	5									7	

Figure 3.9. Vulnerability Score – On the basis of users rankings, a vulnerability score is calculated for each of the activities and resources and according to climatic variable.

			Internal Activities/Resources											External Activities/Resources	
			Beach	Harbour	Coastal Walk	Promenade	Railway Station	Railway Bridge	Water Treatment	Park	Commercial	Housing (a)	Road (a)	Power Supply	Transport
Precipitation	Extreme	Vul.					8	3.5	8	3.5	8	8	8	8	
Fluvial	Flooding	Vul.						6.5	13.25	6.5	6.5	9.25	6.5	6.5	0
Sea	Sea level	Vul.	17	17	7	17								0	0
	Storm surge	Vul.	12.5	12.5	5	12.5			8					0	0
	Erosion	Vul.	17	11	11	17								0	0
Wind	Extreme	Vul.	5.2	5.2	2.6	5.2								0	8.8

Figure 3.10. Future Unadapted Vulnerability Matrix – On the basis of projected changes of exposure to climatic variables, levels of potential future and unadapted vulnerability are developed.

risk assessment approach whereby each impact is assessed according to urgency, the probability of occurrence and the magnitude of loss (human or monetary). This is a useful method as it allows for the employment of both qualitative and quantitative measures, e.g. level of financial loss, where available.

Stage 4 (Assess Your Options)

In this stage, information about priority climate impacts, goals, objectives and constraints collected through the previous steps is used to identify feasible and appropriate adaptation options. This identification process employs an adaptation options database, currently being developed through ICIP (Phase 2), that identifies a wide range of adaptation options to numerous climate impacts and their sectoral implications. The database also ranks available adaptation options according to a number of criteria including: type (grey, green, soft), lead time, sectoral application, mitigation co-benefits, complexity (technical, institutional and social), and decision scale (household/urban, catchment/region, national). Using this multi-criteria analysis-based approach, decision makers can select a number of appropriate and feasible adaptation options. It is at this stage of the analysis that detailed climatic information and data may be required, for example, for those options that are considered *high-regret*, e.g. for substantial adaptation measures, further and more detailed examination of climate projection data may be essential.

Stage 5 (Develop a Plan)

This stage will facilitate users in developing an adaptation plan through the adaptation pathways 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 policy-making processes and to design robustness and flexibility into the adaptation strategy itself (EEA, 2013). Rather than taking an irreversible decision now concerning the one or two best adaptation options to 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://climate-adapt.eea.europa.eu/viewmeasure?ace_measure_id =3510), 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 what is predicted to be the most probable today (Reeder and Ranger, 2011). On this basis, decision makers commit to short and mid-term actions, and establish a plan that can adapt over time to meet changing circumstances and ensure resilience in the longer term.

Stage 6 (Implement, evaluate, monitor & 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 (Fig. 3.5). It is of importance to monitor, evaluate and review the performance of adaptation options/plans. This can be undertaken in terms of the objectives specified in Step 1, recognising that adaptation plans also need to be responsive to new information when it becomes available.

3.3.2 Ireland's Adaptive Social Ecological Systems Simulator (iasess)

Building upon previous research undertaken as part of the EPA-funded project Coastal Climate Adaptation and Development (CLAD), a web-based decision support tool, *iasess* (Fig. 3.11), has been developed to assist decision makers in scoping their locally specific vulnerabilities to climate change, and then to select and evaluate adaptation options to enhance local resilience to climate change.

This tool will allow decision makers to:

- Develop a systematic understanding of the sector/area which they are assessing;
- Analyse projected climate impacts on their area/sector and assess the degree to which the key elements and processes within it are vulnerable to the effects of climate change; and

Figure 3.11. An example of Ireland's Adaptive Social Ecological Systems Simulator (*iasess*) tool.

- Make an initial evaluation of the efficacy and cumulative consequences of current or proposed adaptation measures.

The aim of the tool is to increase the breadth and sophistication of decision makers' understanding of the system they must adapt, achieved through the use of Fuzzy Cognitive Mapping (FCM) techniques. FCM is a 'mental modelling' method that creates a map of cognition which represents an individual's thought processes in a given problem space (Axelrod, 1976). Employing a participatory FCM approach (e.g. Gray et al., 2013), a cognitive map of the system of interest (e.g. local area) is developed, capturing decision makers' conception of how the system is structured and what its core functions are. Within this system map, concepts (Drivers, Pressures, State Changes, Welfare and Responses) are identified and the causal linkages between them are encoded using weighted fuzzy logic terms (Fig. 3.12).

Once a clear understanding of the system has been realised, the cognitive representation of the reference system can be forced by climatic, social and economic scenarios to illustrate how existing vulnerabilities might change in the future. On this basis, users can identify how their current vulnerability might evolve under a range of projected changes in climatic, social and economic conditions. Importantly, this approach allows users to implement adaptation options and assess the extent to which these might enhance their resilience to the impacts of climate change. To date, the development of *iasess* has been centred on the provision of a web-based capability, with the tool being tested and deployed in coastal areas. Work has commenced to enable the use of this tool in water management and its subsequent application to specific water source areas and/or River Basin Districts, noting that as the tool is not prescribed it could be applied in any environment.

3.4 System Architecture and Structure

In response to the requirements identified in Chapter 2, a system architecture and structure was designed and developed and the front-end prototype CIP, the *Climate Ireland* resource (http://www.climateireland.ie), established. In this section, the system architecture of the prototype CIP is introduced, followed by discussion on the system structure and, finally, the front-end prototype CIP website is described.

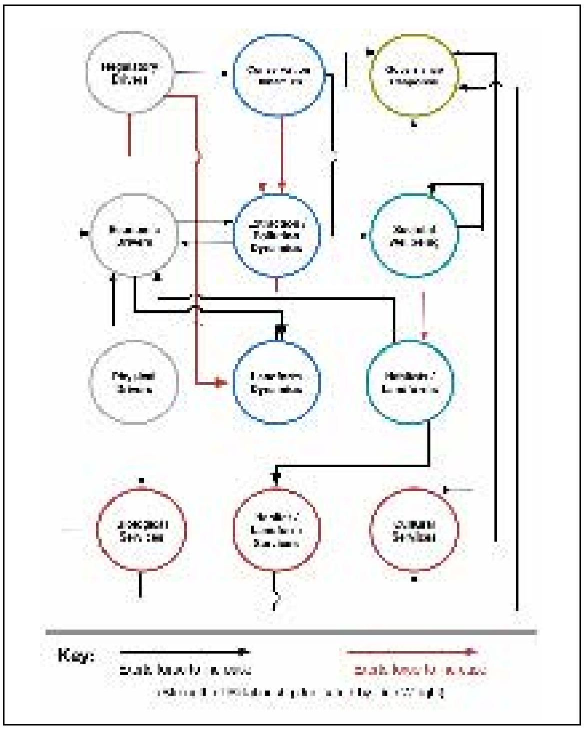

Figure 3.12. An example of Fuzzy Cognitive Mapping.

3.4.1 System architecture

The prototype CIP system follows B/S (browser/server) system architecture. This allows the data provider to load the climate data through a dedicated data provider interface on the server side and the end-users of the platform then access the climate information through an Internet browser on the client side (Fig. 3.13). This architecture allows for the uploading of new data sets and incorporation into the existing database with relative ease.

3.4.1.1 Server-side

Once loaded, climate data are examined and analysed using R packages (GDAL, Maptools) and command line interface tools (e.g. CDO). The GDAL package merges the climate projection data while the Maptools package maps and overlays the data. CDO tools are then used to analyse the data. Analysed data, e.g. up-scaled/average data, are then stored in CouchDB. Upon request by Clutch for predefined data, JVM libraries are then used to draw charts (Incanter) and

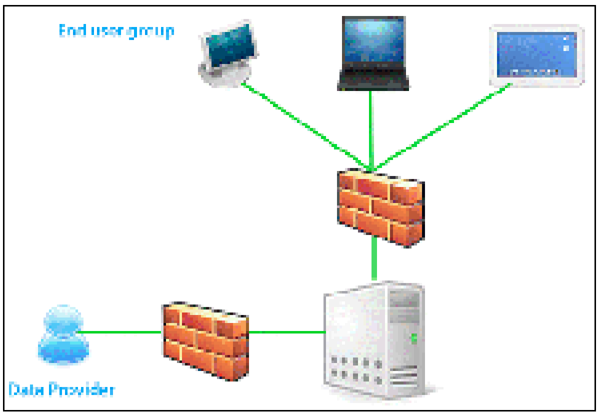

Figure 3.13. Summary diagram of prototype Climate Information Platform (CIP) system architecture.

maps (Analeema), while Enlive is employed for transforming and dynamically populating HTML pages.

3.4.1.2 Client-side

Using browser-based technologies (CSS, HTML, SVG and JS), users request predefined data from the server. These requests are addressed by the server-side JVM platform, which uses Clutch to fetch the required data from the server. These predefined data have been calculated server-side and stored in CouchDB (Fig. 3.14).

3.4.2 System structure

Two main components comprise the system structure of the prototype CIP, the data processing component and the prototype CIP website (http://www.climateireland.ie). These have been implemented to facilitate the data importing, data processing and data publishing and sharing. The system structure is shown in Fig. 3.14, which is discussed below.

3.4.2.1 Data provider and data loading

The prototype CIP has been designed to identify, assemble, evaluate and integrate key climate-relevant data sets and, on this basis, employ and facilitate the effective use of existing knowledge to address end-user requirements. The main data providers include:

- The Community Climate Change Consortium for Ireland (C4i);
- The Irish Climate Analysis and Research Units (ICARUS); and
- The Meteorology and Climate Centre at University College Dublin (UCD).

The prototype CIP has been developed to support climate data sets in a variety of formats (e.g. NetCDF, MS Excel). A data importing interface has been implemented through the R programming language, which allows users to load the climate data in different formats into the prototype CIP. Furthermore, by using this interface, NetCDF-clj, a Clojure wrapper for the NetCDF Java bindings has been used, which ensures that the preferred format for climate data can be accessed directly from within the platform so that offline analysis using desktop tools can be replaced by automated workflow.

3.4.2.2 Data processing

When the climate data are loaded into the prototype CIP, a data processing component is implemented through the R programming language, by which the climate data are processed and analysed from the data source files and the processed climate information is saved in the database. The data processing workflow is summarised in Fig. 3.15.

After the NetCDF files are loaded, the data will be preprocessed in the CDO environment, where the *splitseasons* and *yearmean* commands are used to process the data by time steps. Then the data of each scenario in each of the models are converted to GeoTIFF format, after which they are filtered according to the regions, specifically UK, Ireland, Irish counties and Irish provinces.

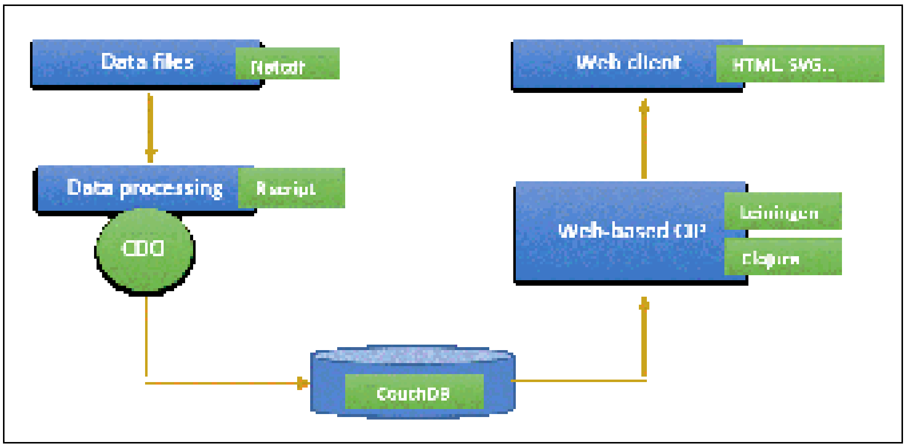

Figure 3.14. Summary diagram of the mechanism for information delivery to respond to user requests.

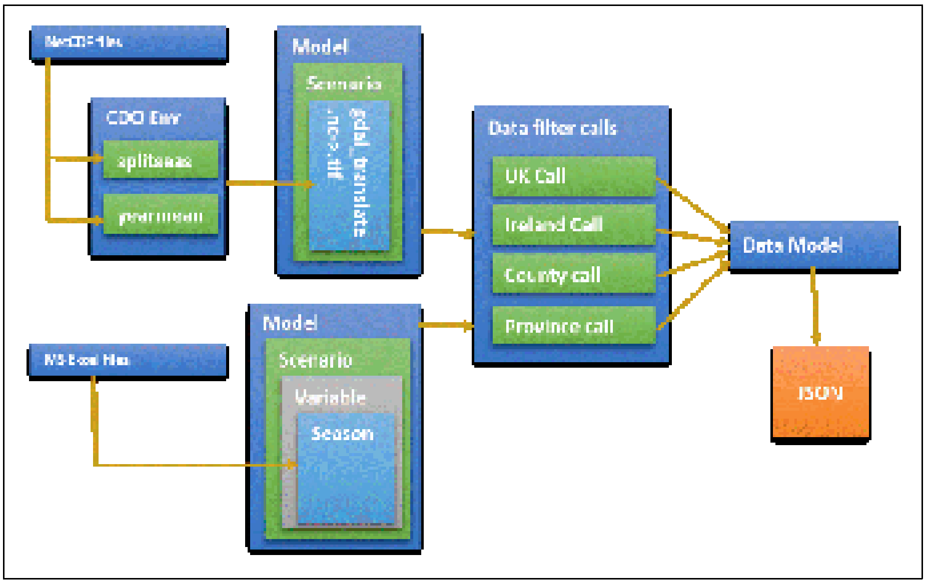

Figure 3.15. Summary diagram of the data processing and analysis procedures employed by the prototype Climate Information Platform (CIP).

Statistical analysis is performed based on the filtered data and the statistical results are transformed into JSON format, which is ready to be saved in a database. Since the output format is implemented as JSON, it will be feasible to store the climate information in a different NoSQL database, which is the initial step of Big Data architecture.

3.4.2.3 CouchDB database

The CouchDB database is deployed in the prototype CIP to save the climate information to be published to the end-users. The CouchDB database is a NoSQL database, which provides an HTTP API interface to access the data and supports MapReduce to process the data further. As a document-based database with little limitation in relation to table structure, it is easier to save the processed climate information from multiple climate models and statistical processes, even when new climate models and statistical methods are considered.

3.4.2.4 Prototype CIP website

The prototype CIP website (http://www.climateireland.ie), as the end-users interface, is implemented to provide climate information and web-based tools for decision making, adaptation planning and other purposes. It is a web-based information system, which is implemented by HTML for static web pages and Clojure programming language for the dynamic part. Leiningen is used to manage the Clojure project and provide the running environment for Clojure codes.

As shown in Fig. 3.16, the HTML web pages provide static climate information in the CIP website. When the end-users request the processed climate data from the

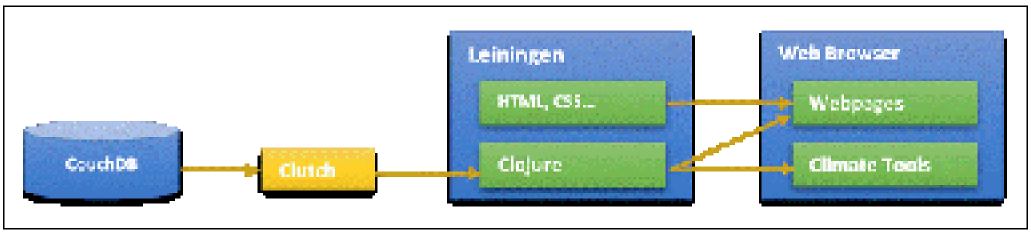

Figure 3.16. Summary diagram detailing the process employed for information delivery through the prototype Climate Information Platform (CIP) website (http://www.climateireland.ie).

CouchDB, these requests are addressed by using the Clutch library to retrieve data from the database. Java libraries are used to draw charts (by Incanter) and maps (by Analeema) by producing SVG image files. Finally, Clojure scripts with Enlive are implemented to populate the climate data and charts into the HTML web pages. Apart from the dynamic web pages, there have been some adaptation tools developed (e.g. *iasess*) using the JavaScript and Clojure scripts. In the implementation of these decision-making tools, JavaScript is used to handle the interaction between the Graphical User Interface (GUI) and the end-users and Clojure scripts are used to handle data retrieving, executing decision-making algorithms and to visualise the results in web pages.

4 Conclusions and Recommendations

4.1 Conclusions

The climate is changing and these changes are expected to continue and intensify into the future. Given the increased knowledge of expected climate impacts, a planned and strategic approach to adaptation is now required to reduce risk and avail of any opportunities that climate change might present. For Ireland, there now exists a wide range of information on the current and anticipated effects of climate change and this information is considered to provide a robust knowledge base with which to begin the process of adaptation planning. However, this information is disparate in both location and format, and thus extremely difficult for decision makers to access and interpret. International experience has demonstrated that centralised online CIPs providing harmonised scientific information adapted to the needs of the end-user groups can support practical climate adaptation decision making.

Through the development of a prototype CIP for Ireland, the first phase of the ICIP project has made substantial progress in developing a CIP specifically tailored for climate adaptation planning 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, through interactions with project stakeholders (end-users and data providers), the first phase of the ICIP project has demonstrated its potential 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.

In collaboration with project stakeholders, the first phase of the ICIP project identified the key areas of information provision required for the initiation and development of adaptation responses in Ireland:

- Currently, Ireland can be considered to be at the early stages of the adaptation planning, with adaptation **not yet considered a high priority for decision makers**. As a result, information to increase awareness and understanding of climate change is required to overcome the more common barriers to climate change adaptation such as scepticism, denial, and knowledge and evidence gaps.

- Climate change is a global problem but the impacts of climate change manifest locally, being determined by local-specific factors, e.g. topography, and local sensitivity and adaptive capacity. Currently, **decision makers face a number of barriers** to allow for the (re)definition of the climate change problem for a specific location/sector of operation and the identification of potential future vulnerability and adaptation measures.

- Planning for future climate change is fraught with uncertainty and decision makers in Ireland **lack the resources and tools** to incorporate this information into their current planning practices. As a result, the provision of specific frameworks and tools to allow decision makers to incorporate climate change information into current planning practices and begin to plan for climate change adaptation is required.

On this basis, a range of web-based resources and tools has been developed, made available through the prototype CIP, to overcome the current information deficit and to facilitate the initiation and development of adaptation responses in Ireland:

- To address the requirement for increased awareness and understanding, informational resources have been developed outlining the specifics of *Climate Change* and *Adaptation* in a user-friendly format. These resources provide the prerequisite information required by decision makers to begin to understand and address the problem of climate change and adaptation and in doing so overcome common barriers to understanding climate change adaptation.

- To facilitate decision makers in coming to an understanding of what climate change might mean for them, the *Climate Information Tool* has collated, integrated and standardised existing downscaled climate change projection data for Ireland, providing decision makers with an overall view of what changes in climate they might expect. In addition, and adopting a vulnerability-based approach, supported by its *Climate Hazard Scoping Tool*, the prototype CIP collates and integrates a wide range of spatial and non-spatial data sets to allow an examination of current levels of exposure to climate hazards and an assessment of how these might change in the future. The *Sectoral Adaptation Scoping Tool* provides decision makers with sectoral-specific information on the key climate change impacts and how these might be addressed through adaptation measures.

- On the basis of available climatic information for Ireland, specific tools (*Adaptation Support Tool* and *iasess*) have been developed and made available through the prototype CIP to facilitate decision makers in making best use of existing information in their planning. These tools adopt a policy-first approach to climate change adaptation and aim to develop a systematic understanding of the impacts (direct and indirect) of current and future climate change on their specific area or system of interest.

4.2 Recommendations

The first phase of the ICIP project has demonstrated the potential for employing a national CIP to support climate adaptation planning in Ireland. Nonetheless, in order to operationalise the prototype CIP developed through the first phase and, in particular, to support decision makers in fulfilling their obligations under the NCCAF (DECLG, 2012), further development is recommended in a number of key areas:

- The provision of improved mechanisms for decision support that directly address the needs of decision making in Ireland, e.g. NCCAF (DECLG, 2012);

- Continued user engagement and training to ensure that information and data delivered through the prototype CIP are of direct relevance and tailored to decision making in Ireland;

- Improvements to the system architecture and methods for data management, interrogation and display; and

- The development of a roadmap for operationalising ICIP.

4.2.1 Improved decision support

Currently, the prototype CIP offers a number of high-level (e.g. national level) scoping tools (e.g. the *Climate Information Tool* and the *Climate Hazard Scoping Tool*) to facilitate decision makers in understanding the implications that climate change might have for their area or sector of interest. However, further development of tools is recommended to facilitate decision makers in meeting the requirements of the NCCAF (DECLG, 2012), particularly the requirement that local and sectoral decision makers consider the issue of climate adaptation in the delivery of services and infrastructure, integrate climate change adaptation considerations into their statutory plans and incorporate climate adaptation into their current planning practices. This will involve the further development of the existing tools to allow decision makers to recognise, at a scale that is appropriate to their decision-making requirements, the inherent uncertainties in climatic information and data and successfully work with them in future planning. Tools must also provide a means of combining climatic and non-climatic information and data (e.g. socio-economic information) to identify, assess and prioritise existing and future vulnerabilities and also facilitate decision makers in developing and implementing an adaptation plan.

4.2.2 User engagement and training

User engagement 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 under a second phase of 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 information and tools delivered are of relevance to users and their decision-making requirements.

- Adaptation is complex and adaptation planning poses a major challenge to decision makers. For example, through its *Adaptation Support Tool*, the prototype CIP adopts a policy-first approach to adaptation. This approach advocates beginning at the scale of the adaptation problem, 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.

4.2.3 Improved system architecture

The prototype CIP has been implemented based on the B/S system architecture, development is managed by the Leiningen R programming language, Clojure scripts are employed on the server side, and the system runs in the JVM environment. However, some improvements are recommended as part of further development:

- The prototype CIP system components have been implemented individually and as a result some of the system functionalities must be carried out manually. In order to achieve a more complete and automatic workflow, further development is recommended to integrate the system components more closely.

- Currently, development of the prototype CIP is managed by Clojure and based on a JVM environment. As a consequence, there is no web server used to support the deployment of the website and this results in difficulties in system tuning, optimisation and monitoring. In addition, given the relatively large amount of climatic data being stored in a single server, there is a potential issue that the R programming language and Clojure scripts cannot provide satisfactory system performance when faced with higher levels of requests. In order to overcome these issues, it is recommended that website development be based on Java and website deployment in a Java web server, e.g. Tomcat. In addition, and on this basis, C++ could be used to handle the business logic that requires heavy computation, e.g. data loading, processing, statistical analysis.

4.2.4 Improved data management

Currently, the prototype CIP has developed and employs a data loading component, which aims to instantaneously load a wide range of spatial and non-spatial data sets. Based on the existing implementation, several improvements can be made to the data management workflow:

- The current data loading component supports both NetCDF and MS Excel files. This data loading component can be improved to support more data formats and data standards such as relational databases, MS Access, plain text files, shapefiles. In addition, more data standards can be considered. For example, the OPeNDAP architecture and protocol, which has been used by a variety of government agencies, e.g. NASA, can be established.

- In its current guise, the data loading implementation can only support loading in batch mode and the process of data loading is started manually, by online control. An automatic workflow for online data is recommended that would support incremental loading and greatly decrease data loading times. Furthermore, a data streaming interface can be considered, by which the new climate data can be streamed into the platform dynamically.

- The prototype CIP has employed the CouchDB database to store processed climate data. However, due to design constraints, it can be difficult to operate this database. As a result, it is recommended that the database be upgraded to support full data operation, MongoDB.

4.2.5 Improved data interrogation and display

The prototype CIP website allows the end-users to interact with the system. From a technical point of view, there is still space to improve the data interrogation and display. For example, the current design of two of the web-based tools, the *Climate Hazard Scoping Tool* and the *Adaptation Support Scoping* tool, uses static data display, where the data must be first loaded, an SVG image then generated and incorporated into the HTML web page. This results in increased waiting times for users. Therefore, efforts can be made in order to improve the data display by considering alternative approaches, such as HTML5 and Ajax. Data cache techniques can be considered to speed up the data loading time.

4.2.6 Roadmap for operationalising ICIP

Following from the development of the prototype CIP resource and in order to ensure the continued development and uptake of this prototype resource by the key stakeholder groups, a roadmap for further development is required. This roadmap should address issues such as embedding, governing and resourcing an operational CIP for Ireland. In order to formulate such a roadmap, a review of international best practice frameworks for embedding, governing and resourcing an operational CIP should be undertaken and expert input should be sought from existing and international CIPs. Following from this, a stakeholder engagement (data providers and end-users) strategy should be put in place to determine the most effective options for operationalising ICIP.

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Acronyms

AOGCM	Atmosphere Ocean General Circulation Model
b/s	Browser/server
C4i	Community Climate Change Consortium for Ireland
CDO	Climate Data Operators
CIP	Climate Information Platform
CLAD	Coastal Climate Adaptation and Development
CSS	Cascading Style Sheets
DDS	Dynamical downscaling
EEA	European Environment Agency
EPA	Environmental Protection Agency
EU	European Union
FCM	Fuzzy Cognitive Mapping
GCM	General Circulation Model
GDAL	Geospatial Data Abstraction Library
GHG	Greenhouse gas
GUI	Graphical User Interface
HTML	Hyper Text Markup Language
iasess	Ireland’s Adaptive Social Ecological Systems Simulator
ICARUS	Irish Climate Analysis and Research Units
ICIP	Climate Information Platform
IPCC	Intergovernmental Panel on Climate Change
JVM	Java virtual machine
NCCAF	National Climate Change Adaptation Framework
OPW	Office of Public Works
RCM	Regional Circulation Model
SDS	Statistical downscaling
SLR	Sea-level rise
SME	Small to medium-sized enterprise
SRES	Special Report on Emission Scenarios
SVG	Scalable Vector Graphic
UCD	University College Dublin
UKCIP	United Kingdom Climate Impacts Programme

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL

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

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

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

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

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

Ár bhFreagrachtaí

Ceadúnú

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

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil

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

Bainistíocht Uisce

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

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol

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

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn

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

Taighde agus Forbairt Comhshaoil

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

Measúnacht Straitéiseach Timpeallachta

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

Cosaint Raideolaíoch

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

Treoir, Faisnéis Inrochtana agus Oideachas

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

Múscailt Feasachta agus Athrú Iompraíochta

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

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil

Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Measúnú Comhshaoil
- An Oifig um Cosaint Raideolaíoch
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

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

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The Development of an Irish Climate Information Platform (ICIP) - Phase 1 (2010-2013)

epaResearch
Climate - Water - Sustainability
Identifying pressures • Informing policy • Developing solutions

Report Author: Barry O'Dwyer, UCC

The aim of this report is to detail the development of Phase 1 of the Irish Climate Information Platform (ICIP) and more specifically the development of a prototype climate information platform for Ireland.

Identifying Pressures

For Ireland, there now exists a large body of work on current and anticipated impacts of climate change and it is considered that there is a robust knowledge base to support the process of adaptation planning. However, this information is disparate, being held by a wide range of organisations, in a variety of formats and with differing means of access and, as a result, it has been difficult for decision makers and citizens alike to access it. International experience has demonstrated that centralised online platforms providing harmonised scientific information adapted to end-user needs can effectively support practical decision making.

Informing Policy

The prototype ICIP has been designed and developed in order to:

1. Improve users' understanding of climatic and adaptation science
2. Act as a centralised repository of authoritative climatic information for Ireland
3. Provide a range of frameworks and tools to allow users to employ climatic information and data in their current planning practices

Developing Solutions

Phase 1 of the ICIP project has made substantial progress in designing and developing a prototype ICIP and has demonstrated the potential to serve as a key resource for communicating and supporting the analysis of impacts, vulnerabilities and adaptation options. As part of this process, the key areas of information provision required for the initiation and development of adaptation responses in Ireland were identified. The prototype ICIP has been successful in collating and integrating a wide range of spatial and non-spatial data sets that are of significant importance in the development of adaptation planning in Ireland. The prototype ICIP has also designed and developed specific resources, frameworks and tools to allow the employment of these data in the development of adaptation plans. In order to operationalise the resource to effectively support decision makers in fulfilling their obligations further development of the resource is required

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