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

National Climate Change Adaptation Framework

Building Resilience to Climate Change

Department of the Environment, Community and Local Government

December 2012

MINISTER'S FOREWORD

In line with global trends, Ireland's climate is changing and the scientific consensus is that further changes are on the way. Incremental changes in climate are already evident in Ireland, including changes in our average temperature, rainfall intensity, and patterns, as well as subtle changes to our ecosystem. While doubts remain in relation to both the rate and extent of climate change impacts that Ireland will experience, we can be nonetheless confident that over the coming years climate change will affect many sectors of our economy and society. The impacts are uncertain but concerted action is required to prepare for and deal with these changes in Ireland. We need to implement measures that will help the public to adapt to these changes.

Through our membership of the European Union, Ireland is pro-actively supporting ongoing efforts under the United Nations Framework Convention on Climate Change to reach agreement on a comprehensive, global response to the threat of climate change. In December 2011, Governments gathered in Durban, South Africa agreed to launch negotiations on a global legal framework applicable to all countries. The new framework is to be adopted by 2015 and implemented from 2020 onwards. Ireland has already signed up to meeting demanding and legally-binding greenhouse gas (GHG) emission reduction targets under the Climate and Energy Package agreed by the EU in December 2008.

Even if the world succeeds in limiting and then reducing global greenhouse gas emissions to a safe level, our planet will continue to respond to the historic accumulation of GHG in the atmosphere. These now exceed levels experienced for more than 250,000 years. We are all vulnerable to further changes, driven by the evolving impacts of these emissions which are 'locked in' to the Earth's climate system.

At the end of 2011, I published a review of climate change policy to encourage a wide-ranging debate on the future direction of climate policy in Ireland. I also commissioned independent analysis from the Secretariat of the National Economic and Social Council.

In tandem with this extensive programme of work on climate mitigation, I fully recognise the need to advance the agenda on climate change adaptation. In 2009, the European Commission published a "*White Paper on Adaptation to Climate Change"*, outlining the framework for adaptation measures and policies to reduce vulnerability of all 27 EU Member States to the impacts of climate change. The Commission is now preparing an EU Adaptation Strategy, to be published in 2013, with the objective to:

- provide for a more resilient Europe at national, regional and local level;
- facilitate the exchange of good practices;

- strengthen the knowledge base on climate change impacts, vulnerability and adaptation and
- mainstream climate adaptation into policies, strategies and programmes at EU level.

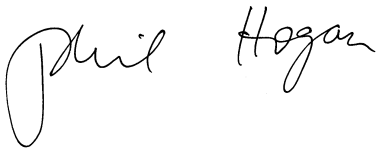
The EU policy framework on climate change adaptation has guided our national approach as we prepare for the anticipated changes in Ireland's climate. Adaptation to the effects of climate change requires action to both manage the risks and to make adjustments to reduce our vulnerabilities. It is an essential component of our long term, strategic economic planning.

An integrated approach, involving all stakeholders on all institutional levels, is essential. While the Government can and will provide leadership, effective adaptive action must be underpinned by adequate and appropriate measures at sectoral and local levels. Much work has already been done in recent years, by the Environmental Protection Agency (EPA) and others, to provide the evidence base necessary to inform the development of the national adaptation agenda.

This "*National Climate Change Adaptation Framework"* provides the policy context for a strategic national adaptation response to climate change in Ireland and is designed to evolve over time as planning and implementation progresses, and as further evidence becomes available. It provides a clear mandate for the relevant Government Departments, Agencies and local authorities to commence the preparation of sectoral and local plans, and to publish drafts of these plans by mid-2014. The EPA's "*National Adaptive Capacity Assessment"* has advised that enough information exists to start to plan for the positive and negative impacts of climate change. With effective co-coordinated planning, we will ensure that the adaptation challenge is addressed in a timely, progressive and determined manner as part of the essential transition towards a competitive, low-carbon, climate resilient future.

This Framework plan is about helping people to cope and reduce the disruption to their lives from the impacts of climate change; to understand the changes required to enhance their quality of life; and to help our economic recovery take account of these changes to climate patterns and extreme events so that jobs are protected.

Climate adaptation is a complex and multifaceted issue. Questions need to be asked, options generated and decisions made that will increase our resilience to the impacts of climate change. It is up to all stakeholders now to show commitment and act to implement this Framework and secure a more sustainable Ireland, both economically and environmentally.



Phil Hogan, T.D.,
Minister for the Environment, Community and Local Government.

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EXECUTIVE SUMMARY AND OVERVIEW OF ACTIONS

The *National Climate Change Adaptation Framework* provides a strategic policy focus to ensure adaptation measures are taken across different sectors and levels of government to reduce Ireland's vulnerability to the negative impacts of climate change. The aim of this Framework is to ensure that an effective role is played by all stakeholders in putting in place an active and enduring adaptation policy regime. The governance structure provides for climate change adaptation to be addressed at national and local level. Similar to the approach being taken at EU level in the *White Paper on Adaptation*, it is intended to follow a two-phased approach to adaptation in Ireland.

The *first phase*, which is already well underway, is focused on identifying national vulnerability to climate change, based on potential impacts relative to current adaptive capacity. Reliable information on the range of socio-economic vulnerabilities, the costs and benefits, and the options available and appropriate to Ireland, are key elements to inform effective adaptation planning. Much work has already been done in recent years, by the Environmental Protection Agency (EPA) and others, to provide the evidence base necessary to inform development of the national agenda. Sufficient high quality data and information already exists to begin the adaptation planning process now. Information dissemination systems are being further developed to inform all levels of decision-making.

The *second phase* involves the development and implementation of sectoral and local adaptation action plans which will form part of the comprehensive national response to the impacts of climate change. Sectoral plans will be prepared by the relevant Department or Agency and will be adopted by the relevant Minister. Draft sectoral plans will be published by mid-2014 and, following approval should be reviewed at least every 5 years. However, where a sectoral mitigation plan is required under the forthcoming primary legislation on climate change, both mitigation and adaptation plans should be prepared and reviewed in tandem to ensure full coherence of analysis and actions.

The Government recognises the critical importance of planning and development measures in the overall strategic approach to adaptation to climate change. The spatial planning process, with full engagement of key stakeholders, provides an established means through which to implement and integrate climate change objectives, including adaptation, at local level. Current guidelines on flood risk management require local authorities to be vigilant in ensuring that risks of flooding into the future are identified and integrated into the planning process. These guidelines are particularly important in reviewing development plans, especially in zoning land for development. As local authorities review their development plans, they will now be required to integrate climate change adaptation and mitigation considerations into their plans. For the purposes of this Framework, local authorities should make an assessment of the extent to which existing development plans adequately address adaptation to climate change and, where appropriate, aim to

have a review process of their development plan underway by mid-2014 (if necessary, through amendment and variation procedures) if climate adaptation is not already adequately addressed. Local development planning will, in effect, become the mechanism for the delivery of local climate adaptation action.

The Government will support and facilitate this approach through the preparation of guidelines for integrating adaptation into development plans as well as guidance on adaptation proofing of Strategic Environmental Assessment. The Department of the Environment, Community and Local Government and the EPA will work together on the preparation of these guidelines.

In order to ensure effective monitoring and review, it is important that adaptation plans identify those who will be responsible for monitoring the plan, the criteria against which plans will be reviewed, the review process mechanism and the timescales for reviews to be carried out. Future work under the EPA's Climate Change Research Programme will take account of the need for adaptation indicators to assist in monitoring and review of plans as well as allowing for comparison across plans. This will also assist in the national reporting requirements which may arise within the EU and at the wider international level under the UN Framework Convention on Climate Change.

Overview of Actions

Research and Knowledge Base

- The Department of Environment, Community and Local Government will continue to prioritise the filling of gaps in climate research needs and ensure that accessible information will continue to be provided to support the adaptation decision-making process. Other research work on adaptation in specific sectors is often carried out or commissioned by other Government Departments/bodies such as the OPW, Teagasc, Coford, etc. This research work will also continue to be supported and promoted by other relevant Departments.
- The Department of the Environment, Community and Local Government will continue to support the EPA in continuing to play a lead role in building the evidence base and tools to help organisations adapt to climate change.
- To promote a more consistent approach to the dissemination of adaptation research and best practice, the EPA will continue to lead in the development of a web-based tool (to be known as the Climate Platform (CIP)) to help stakeholders plan their own decisions on adapting to climate change. The Climate Platform will include details of all EPA funded research on adaptation and the associated findings. Other State bodies will also provide specifics of their adaptation research for publication on the Platform.

- Future work under the EPA's Climate Change Research Programme will take account of the need for adaptation indicators to assist in monitoring and reviewing of plans as well as allowing for comparison across plans.
- The Department of the Environment, Community and Local Government will continue to support Met Éireann in its development of climate prediction systems and provision of climate services for Ireland. Met Éireann will integrate its efforts with European and international initiatives within the overall co-ordination of the World Meteorological Organisation.
- The Department of Environment, Community and Local Government will continue to support the development of enhanced national co-ordination of observation systems under the leadership of the EPA and Met Éireann who will, with the assistance of other responsible bodies and institutions, provide periodic updates on the state of Ireland's climate system and provide analysis of data from this system.

Governance

- The Department of the Environment, Community and Local Government will lead and co-ordinate on international, EU and national climate adaptation policy, working as appropriate through the Cabinet Committee system. It will support and promote innovative policy-making on climate adaptation at all levels, and support strategic decision-making on how best to address the impacts of climate change.
- Individual Ministers will take responsibility for adaptation in their respective sector(s).
- The Department of the Environment, Community, and Local Government will support implementation of the Framework by local authorities.
- The City and County Managers' Association (CCMA) will play an advisory role and facilitate the exchange of best practice in the implementation and development of climate adaptation policy at local level, fostering a shared approach to managing the impacts of climate change.
- In supporting local communities, local authorities must consider the issue of climate adaptation in the delivery of its services and infrastructure.

Sectoral Plans

- Each relevant Government Department (or State Agency, where appropriate) will prepare adaptation plans for their sectors.
- Draft sectoral plans, based on sectoral risk assessments and following consultation with relevant stakeholders, to be published, by mid-2014 and adopted as quickly as possible thereafter.
- Sectoral adaptation plans should be revised and updated at least every 5 years. However, where sectoral mitigation plans are required under the proposed forthcoming primary legislation on climate change, both adaptation and mitigation plans should be prepared and reviewed in tandem to ensure full coherence of analysis and actions.

Local Plans

- Local Authorities will take a proactive approach to climate change adaptation by integrating adaptation into the development of relevant policies, plans and programmes.
- As local authorities review their city and county development plans, they should integrate climate change adaptation (as well as mitigation) considerations into their statutory plans.
- Local authorities should aim to have the review process of their development plans underway by mid- 2014 (if necessary, through amendment and variation procedures) to include climate change adaptation if this is not already adequately addressed. As part of this process, local authorities will continue to collect evidence, raise awareness, and create the necessary relationships and actions needed to deliver purposeful adaptation measures.
- Once adopted, local plans will be reviewed thereafter in line with the cycle of development plan review under the planning and development legislative code.
- The Department of the Environment, Community and Local Government will support and facilitate this approach through the preparation of guidelines for integrating climate adaptation into development plans as well as guidance on adaptation proofing of Strategic Environmental Assessment.

Stakeholder Consultation

- Government Departments and bodies will adopt an open, transparent, and inclusive approach to sectoral adaptation planning, with interested organisations and stakeholders being given early and adequate opportunity to input to the process of preparing adaptation plans.
- Public bodies will engage directly with others that are influenced by their policy decisions and embed adaptation as necessary into key areas of work such as investment in infrastructure, and the procurement of goods and services.
- Local authorities will continue to consult and encourage partnership with stakeholders when addressing adaptation matters at a local level, particularly through the open and participative process for making development plans, into which local adaptation planning is to be integrated.
- Each relevant Minister will foster a co-operative relationship with the private sector, and in particular the insurance sector, for the collection and dissemination of data on weather and catastrophe risk.

1. SETTING IRELAND'S ADAPTATION IN CONTEXT.

1.1 Introduction

The scientific evidence indicates that the Earth's climate is changing and, without taking appropriate and early action, climate change will have potentially disastrous effects for many areas of the planet. Uncertainties remain in relation to the level and extent of these impacts, and how they will emerge in the coming decades. The greatest uncertainly lies in how effective global actions will be in reducing greenhouse gas (GHG) emissions and stabilising the Earth's climate systems. Notwithstanding these uncertainties, what is clear is that all regions and countries, including Ireland, will experience impacts.

Climate change will result in a range of impacts across a number of sectors that are likely to exacerbate existing vulnerabilities. Adaptation actions will be required to avoid or reduce the adverse impacts of climate change and take advantage of any positive impacts. For Ireland, it is important to be able to build on positive opportunities that may be presented to respond effectively to reduce any negative impacts and to prepare for longer term consequences.

The Intergovernmental Panel on Climate Change (IPCC)[1] provides the most authoritative international scientific assessment of climate change. In its Fourth Assessment Report (AR4, IPCC, 2007) it concludes that:

- warming of the climate system is unequivocal, as is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea levels;
- climate change will expose tens to hundreds of millions of people globally to water stress. Such additional pressures on water availability and accessibility as a result of drought has the potential to compromise human development and livelihoods in many parts of the world; future climate change will make dry areas drier and increase the risk of flooding in others. More than a billion people may face fresh water shortages by 2050;
- in some countries, crop yields could halve by 2020;
- health problems such as increased rates of death, disease and injuries will also increase as a result of heat waves, floods, storms, fires and droughts related to global warming; and
- there are likely to be widespread biodiversity losses: 20 to 30% of plant and animal species globally will face an increased risk of extinction if the average

[1] The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts, Further information can be found at http://www.ipcc.ch/index.htm

global temperature increases by more than 1.5 to 2.5 degrees Celsius over pre-industrial levels.

While these impacts will mostly occur in more extreme climate areas outside of Ireland, they will, nonetheless, have indirect impacts for Ireland, where we will also directly experience the increasing effects of climate change on the way we work and live. Analysis of meteorological data for Ireland shows that the climate has changed here over the past 100 years. The clearest trend is evident in the temperature records - both high and low - but there is also a trend towards more intense and frequent rainfall.

The projected impacts of climate change in Ireland include:

- increasing average temperatures;
- more extreme weather conditions including storms and rainfall events;
- an increased likelihood of river and coastal flooding;
- water shortages, particularly in the east of the country;
- changes in types and distribution of species; and
- the possible extinction of vulnerable species.

1.2 What is Adaptation

Adaptation refers to the adjustment or preparation of natural or human systems to a new or changing environment, with the aim of moderating harm or exploiting beneficial opportunities. Climate change adaptation comprises all spontaneous responses and planned action taken to cope with the impacts of changing climate conditions.

Adaptation is needed to tackle current climate variability and to anticipate possible future changes, with the aim of cost-effectively reducing risk and damage, and exploiting any potential benefits. While considerable uncertainties remain in relation to future climate conditions and the rate of climate change, the underlying trends are evident and projected to continue. We therefore now need to put in place the policy framework for adaptation planning to respond to these challenges.

1.3 What's the Link with Mitigation?

Adaptation and mitigation are essential elements in addressing the challenges and opportunities presented by climate change. **Mitigation** refers to actions to reduce emissions of the greenhouse gases that are driving climate change; it includes strategies to reduce activities that give rise to greenhouse gases and enhance sinks for greenhouse gas in forests and other part of the biosphere. However, it is accepted that, even if countries around the world succeed in limiting and then reducing greenhouse gas emissions, the climate system will continue to respond to

the atmospheric build-up of greenhouse gases over past decades. Accordingly, given that climate change impacts on natural and human systems will continue and evolve for the foreseeable future, measures to manage these impacts, both in terms of moderating the harmful impacts and exploiting beneficial opportunities, are essential; in essence, a robust process of climate **adaptation** is required.

Sectoral and local actions to adapt to climate change should have synergies with efforts to mitigate climate change. An example of a link between mitigation and adaptation can be seen in the area of space heating. Poorly constructed buildings require extensive use of energy for heating or air conditioning to address extreme high and low temperature events and consequently increase greenhouse gas emissions. On the other hand, robust retro-fitting and re-design of buildings to provide a more comfortable working and living environment in the face of changing climate can be seen as an adaptation measure.

This example highlights the opportunities that can arise from both adaptation and mitigation. Innovative solutions to the challenges involved can give rise to considerable economic opportunities through technological developments and new environmental products and services, contributing to improved quality of life in Ireland and elsewhere.

1.4 Adaptation Works Better if it's Planned

Many adaptive actions can be taken by individuals, households and businesses as they independently adjust to their circumstances due to experiences or perceptions about climate risk. This can include putting in place short-term adjustments to practises or infrastructure such as changing crop planting dates, or implementing flood protection measures for individual houses and businesses. These autonomous adaptation actions can offset some of the negative impacts of climate change, and often take place without the active intervention of policy. However, autonomous adaptation is unlikely to be optimal as there will be missed efficiency gains that would accrue from concerted actions and autonomous adaptation action in one sector may have unintended adverse impacts for other sectors, resulting in maladaptation. Maladaptation occurs when an adaptation action or investment increases, rather than reduces, overall vulnerability to climate change impacts. An example of maladaptation could be an increased focus on provision of air-conditioning in new buildings to manage increased temperatures rather than improved building techniques that will maintain comfortable temperatures.

Many adaptation measures to date have been reactive in nature, taken directly to respond to extreme weather events that have occurred. Given the increased knowledge of climate change impacts, it is now necessary to develop adaptation planning so that we are better placed to deal with future events. Unlike autonomous adaptation, this planned approach to adaptation is the result of a deliberate policy decision, based on the awareness that conditions have changed or are expected to

change, and that some form of action is required to reduce risk or avail of opportunities. By planning and anticipating climate impacts, it is possible to reduce the cost and maximise the effectiveness of adaptation actions.

Adaptation responses are determined by the vulnerability of the system (physical or social) to climate change impacts and its adaptive capacity (or ability to adapt). Adaptation strategies should aim to address climate change impacts and also increase adaptive capacity (see Figure 1).

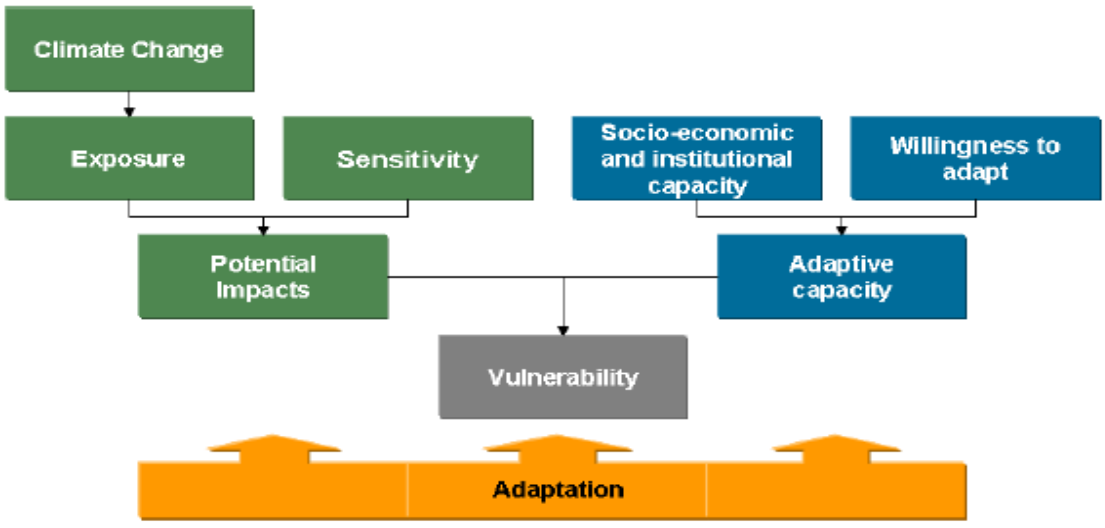
Accordingly, a number of building blocks should ideally be in place to aid in the development of a comprehensive and coherent national adaptation response:

1. **A robust knowledge base** – a clear understanding of expected climate change exposure and the sensitivity of sectors, areas, ecosystems and populations and the consequential potential impacts (both observed and projected).
2. **An assessment of adaptive capacity** - socio-economic and institutional capacity and willingness to adapt.
3. **A vulnerability assessment** – bringing together the assessments of potential impacts and adaptive capacity, in order to assess vulnerability.
4. **Identification of adaptation requirements and the associated options, together with an estimation of costs and benefits.**
5. **Action plan** - detailing adaptation actions required and an associated implementation plan.
6. **A review mechanism** – to review the success or otherwise of adaptive actions.

When these blocks are in place it is possible to develop a well-informed adaptation response.

Figure 1:

Climate Change Adaptation; Potential Impacts, Adaptive Capacity and Vulnerability



1.5 Uncertainty about Scale and Scope of Climate Impacts

> *Knowledge about future climate – particularly the local impacts of global climate change trends – is incomplete. Decision-makers will have no option but to make policy and investment choices under uncertainty.*
>
> - Report of the Economics of Climate Change Working Group, 2009[2]

There are uncertainties associated with the assessment of current vulnerabilities to the impacts of climate variability and identifying and evaluating adaptive responses. All the science, however, points to increase in temperatures, changes in rainfall patterns, rising sea levels and increases in extreme events. A 'wait and see' approach is not an option for climate change adaptation; adaptation decisions, particularly those with long-term implications, need to be made now, on the basis of the best available, albeit to some extent incomplete, information, drawing on approaches to formulating strategies that are both prudent and robust to uncertainty.

1.6 What's Happening at The Moment On Climate Adaptation?

1.6.1 Internationally

International actions to address climate change are progressed under the 1992 UN Framework Convention on Climate Change (UNFCCC)[3] The objective of the UNFCCC is to stabilise atmospheric GHG concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. Recent decisions under the UNFCCC commit all Parties to formulate, publish, implement and update adaptation plans, as well as to cooperate on adaptation (see Section 3.1).

As a Party to the UNFCCC, Ireland pledged up to €100m to the EU package of €7.2bn of Fast Start Finance for the period 2010-2012 to support adaptation and mitigation efforts in developing countries. At the end of the period, it is estimated that Ireland had, in fact, allocated €110 million in Fast Start Finance, much of it directed at adaptation-related actions in Least Developed Countries. The EU and other developed countries are continuing to work in a constructive manner towards the identification of a path for scaling up climate finance from 2013 to 2020 from a wide

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[2] Economics of Climate Adaptation Working Group is a partnership between the Global Environment Facility, McKinsey & Company, Swiss Re, the Rockefeller Foundation, ClimateWorks Foundation, the European Commission, and Standard Chartered Bank. Further information at http://mckinseyonsociety.com/shaping-climate-resilient-development/

[3] In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted as the basis for a global response to the problem of climate change.. More information can be found at http://unfccc.int/2860.php

variety of sources to reach the international long-term committed goal of mobilising up to US$100 billion per year by 2020.

1.6.2 Adaptation Policy in the EU

The European Commission published its White Paper on *Adapting to Climate Change: Towards a European Framework for Action*[4] in April 2009, with the aim of increasing the climate resilience of a number of sectors, including health and social policies; biodiversity, ecosystems and water; coastal and marine; and production systems and physical infrastructure. The framework, which follows a two-phase approach to adaptation, respects the principle of subsidiarity and supports overarching EU objectives on sustainable development. The 2009 White Paper recognises that close co-operation among stakeholders within the EU and at national, regional, and local levels will be required in order to achieve the overall aim of mainstreaming climate adaptation into European and Member States policies.

The EU White Paper notes that the EU has a particularly strong role when the impact of climate change transcends the boundaries of individual countries (e.g. river and sea basins and bio-geographic regions). Moreover, given that policy in a range of sectors such as agriculture and fisheries are integrated at EU level through the Single Market and common policy approaches, there is a clear role for co-ordinated adaptation action at that level. The White Paper sets out clear objectives in relation to adaptation and supports these with specific actions for the EU and for Member States.

The first phase of the EU approach (2009 – 2012) has focused on the preparation of the overall European adaptation framework, including collecting relevant information and identifying climate change impacts in the EU, mainstreaming adaptation measures into key EU policies and strengthening international co-operation in the field of adaptation. This phase will culminate with the expected publication, in March 2013, of an EU Adaptation Strategy, at which point the focus of attention will turn more fully to implementation. In that context, the finalisation of the next Multiannual Financial Framework 2014-2020, and the extent to which climate change is mainstreamed into funding at EU level across key spending programmes, including the Common Agricultural Policy (CAP), Structural and Cohesion Funds, Research etc., is of crucial importance. The proposed new LIFE Regulation (*The establishment of a Programme for the Environment and Climate Action Regulation (LIFE)*[5]) will also support a significant programme of action in the climate area.

[4] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF

[5] http://ec.europa.eu/environment/life/about/documents/COMM_PDF_COM_2011_0874_F_EN.pdf?reference=IP/11/1526&format=PDF&aged=0&language=EN&guiLanguage=en

1.6.3 Adaptation Policy in Ireland

Ireland's second *National Climate Change Strategy*[6] was published in April 2007. A policy review process, which will lead ultimately to the development of a national low-carbon roadmap to 2050, is now underway. While the 2007 Strategy focuses primarily on greenhouse gas mitigation, it did recognise the importance of the adaptation side of the climate change agenda and established the principle of integrating adaptation into decision-making at national and local level.

In 2010, Ireland's progress in addressing both mitigation and adaptation was reported on in our *5th National Communication*[7] under the UNFCCC. The report focused primarily on developments during the period 2005-2007. Considerable adaptation-related work has been taken forward over recent years, including research, analysis and development of knowledge and capacity, and this has provided a strong platform for the preparation of this National Climate Change Adaptation Framework.

Ireland also recognises the international impacts of climate change and, through Irish Aid, supports programmes in developing countries which build the capacity of policy makers to integrate mitigation and adaptation into their national development plans.

1.7 Ireland's Framework for Adaptation

This national policy framework for climate change adaptation draws together the work already being done by Government and the wider public sector on adaptation in Ireland, with the objective of:

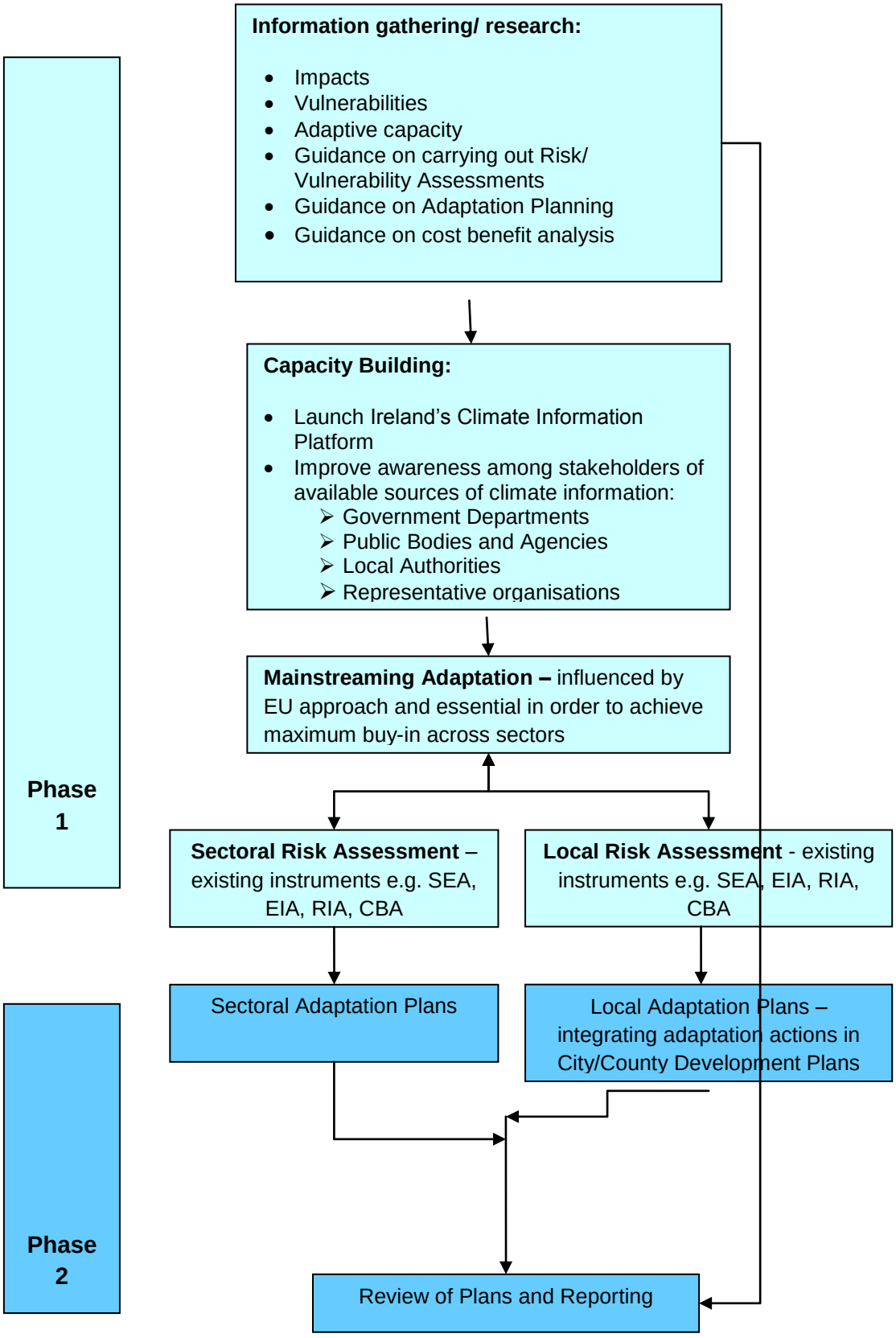
- providing the policy context for a strategic national adaptation response to climate change:
- promoting dialogue and understanding of adaptation issues:
- identifying and promoting adaptation solutions and
- committing to actions to support the adaptation process.

This framework is a first step in a longer-term process which will evolve and strengthen over time as the knowledge base evolves and as the policy response matures. Similar to the two-phase approach set out in the EU White Paper, a two-phase approach is also being followed nationally (see Figure. 2). Work in Phase 1 is already well underway and has been advanced sufficiently to allow Phase 2 to now move forward in parallel.

6 http://www.environ.ie/en/Environment/Atmosphere/ClimateChange/NationalClimateChangeStrategy/PublicationsDocuments/FileDownLoad,1861,en.pd

7 http://maindb.unfccc.int/public/country.pl?country=IE

Figure 2: Strategic National Adaptation Response:



2. IMPACTS, VULNERABILITY AND ADAPTIVE CAPACITY – THE KNOWLEDGE BASE

A large body of work has been undertaken by various agencies and sectors within Ireland with the specific objective of informing policy and decision-making on mitigation of GHG emissions and options for adaptation to climate change. The EPA plays a lead role in climate research and works closely with a number of Government Departments, State Agencies and other stakeholders on climate change issues.

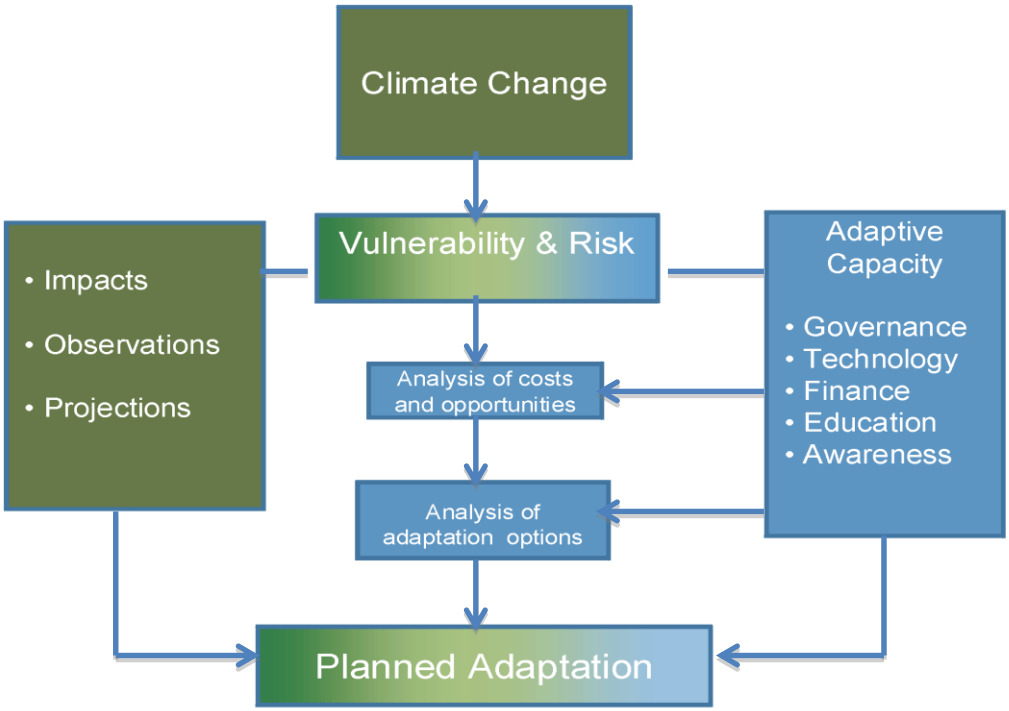
The Climate Change Research Programme (CCRP)[8] established and administered by the EPA, supports research addressing specific knowledge gaps of direct relevance to the *National Climate Change Strategy.* The CCRP research outputs are aimed at strengthening data and the information base, and filling gaps in knowledge; a significant number of research projects have been funded to date with a focus on the policies and measures needed to adapt to the impacts of climate change

2.1 Impacts, Vulnerability, and Adaptive Capacity

The extent to which risks and effects of a changing climate will be experienced by society, the economy and the environment depends both on the impacts of climate change and the inter-related concepts of vulnerability, and adaptive capacity. Effective adaptation planning requires reliable information and consideration of each of these factors. Figure 3 below illustrates the EPA's step-wise approach to planned adaptation addressing impacts, vulnerability and adaptive capacity.

[8] http://www.epa.ie/whatwedo/climate/climatechangeresearch/

Figure 3: EPA Stepwise Approach to Planned Adaptation



2.1.1 Impacts

A substantial amount of information exists on relevant climate change impacts. *A Summary of the State of Knowledge on Climate Change Impacts for Ireland*[9] presents a synthesis of the current state of knowledge on observed and expected impacts for Ireland, the main elements of which are set out in Figure 4 below.

[9] http://www.epa.ie/downloads/pubs/research/climate/CCRP1(low).pdf

Figure 4: Observed and Projected Impacts for Ireland

	Observed Impacts	Projected Impacts
Temperature	Temperatures have increased by 0.8ºC since 1990; an average of 0.075ºC per decade.	Average temperatures will rise by between 1 ºC and 3ºC by 2100 compared to the 1961-2000 average.
Precipitation	An increase in average annual rainfall, especially in the West with regional sessional differences.	Wetter winters in the west, drier summers in the south-east with between 5-25% less rainfall in 2021 to 2060 compared with 1961-2000 period.
Extreme Events	A decrease in storm frequency but increased storm intensity.	Slightly fewer storms but more intense with a northward shift in storm tracks.
Sea Levels	During satellite era a sea level rise of 3.5cm per decade	A rise of 60cm to 2100; however, considerable melting of land ice could intensify this impact.

2.1.2 Vulnerability

Vulnerability is a measure of the susceptibility of a sector, region, group or activity to adverse external drivers. A vulnerability assessment identifies who and what is exposed and sensitive to climate change and considers the factors that make people or the environment susceptible to harm. It builds upon the information available on observed and projected impacts and is useful in the development of strategies or policies to limit the adverse impacts of climate change and variability on environmental and human systems.

As part of Ireland's adaptive planning process, the EPA is currently funding research at National University of Ireland, Maynooth to develop tools for assessing vulnerability. The objective of this research is to identify the sectors/areas most vulnerable to the impacts of climate change and will underpin the process of prioritising responses.

Some sectors have already independently begun the process of identifying key vulnerabilities for their business. The report by the Irish Academy of Engineering *Ireland at Risk Critical Infrastructure – Adaptation for Climate Change*[10] and the

[10] http://www.iae.ie/site_media/pressroom/documents/2009/Nov/17/Ireland_at_Risk_2.pdf

Heritage Council and Fáilte Ireland's *Climate Change, Heritage and Tourism, Implications for Ireland's Coast and Inland Waterways*[11] are examples of initiatives of this kind. These studies show how analysis of climate change has been advanced at key sectoral levels, using information resulting from investment in climate projections to assess impacts and inform planning.

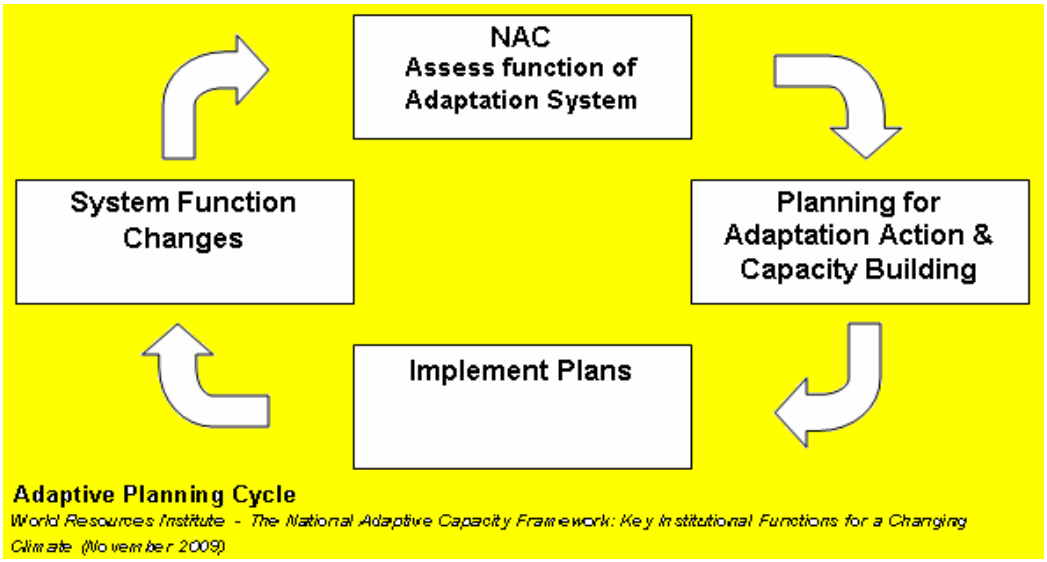
2.1.3 Adaptive Capacity

In 2009, the World Resources Institute (WRI) published a *National Adaptive Capacity Framework*[12] which identifies a fundamental set of national level functions that all countries will need to perform if they are to adapt effectively to climate change over time. Under the National Adaptive Capacity (NAC) approach, adaptation is treated as an organic process – one which inevitably will grow and evolve in unexpected ways, since every country has a unique set of actors who play different roles in adaptation.

The framework consists of five key functions within which national capacity is evaluated:

i) assessment;
ii) prioritisation;
iii) coordination;
iv) information management and
v) climate risk reduction.

Figure 5: WRI - Adaptive Planning Cycle



11 http://www.heritagecouncil.ie/fileadmin/user_upload/Publications/Marine/ClimateReportWeb_version_june_09FINAL.pdf

12 http://pdf.wri.org/working_papers/NAC_framework_2009-12.pdf

The EPA, informed by the WRI model, published Ireland's *National Adaptive Capacity Assessment*[13] in March 2012. A key finding of the Assessment is that enough information exists to start climate change adaptation planning and to implement priority actions. The report also recommends the importance of building on existing tools such as Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA). The EPA's Assessment represents a critical step in progressing the climate adaptation agenda.

2.2 Other Knowledge Resources

There are numerous websites and publications that offer tools to guide organisations through the adaptation process. The EU Clearing House Mechanism[14] on climate change impacts, vulnerability and adaptation, known as Climate-Adapt, was launched in March 2012 in response to the demand for effective mechanisms for sharing information and for developing adaptive capacities within Europe. It is a web-based platform for the exchange of information and is aimed at policy makers and practitioners – such as engineers, planners and administrators – who can learn from the experience of others facing similar challenges and already carrying out adaptation actions elsewhere. The site features a continuously-updated database of adaptation strategies and actions at the transnational and country level. There are also case studies on initial adaptation actions at local and sub-national level. Ireland has contributed to the development of this initiative and national relevant information is contained on the site.

2.2.1 Systematic Observations

As indicated earlier, the EPA plays a leading role in climate change research and the development of the knowledge base. Met Éireann is also at the forefront of national research efforts on climate change. The Community Climate Change Consortium for Ireland[15] (C4I) which is based in Met Éireann has built a substantial national climate modelling capability and a comprehensive data set on the future climate of Ireland.

Article 5 of the UNFCCC recognises the vital roles of Research and Systematic Observations (RSO) in providing information on climate change. Projections and analysis of future climate conditions are provided by global and regional climate models. Climate model outputs have, to date, been largely focused on mid and end-of-century climate conditions, under a range of GHG emissions scenarios. These are

[13] http://www.epa.ie/downloads/pubs/research/climate/Final.CCRP_10_web.pdf and http://www.epa.ie/downloads/pubs/research/climate/CCRP_9_web.pdf

[14] http://climate-adapt.eea.europa.eu/

[15] http://www.c4i.ie/

vital for understanding the longer term implications of climate change and to inform the necessary policy actions required to avoid the most adverse climate impacts. However, shorter-term issues largely determine the practical responses in a range of planning and decision making processes.

Two tracks are being progressed to address the issue of shorter-term climate predictions. Firstly, arising from the 2009 World Meteorological Organisation (WMO) Third World Climate Conference, there has been a major focus on the development of shorter-term climate predictions and climate services. The second track is the development of systematic observation systems of essential climate variables. In response to the requirement of the UNFCCC for analysis of the responses of the planet and its climate system to enhanced atmospheric GHG levels, the WMO established a process to create the Global Climate Observation System[16] (GCOS). A standardised measuring system has been established by the GCOS to measure Essential Climate Variables (ECV's), including surface air temperatures, upper air temperatures, atmospheric composition (ozone levels, carbon dioxide and aerosol properties), ocean surface temperatures, snow cover, ice cap cover, river discharge, soil moisture, etc. Some variables like the Earth's radiation budget (i.e. a concept used for understanding how much energy the Earth gets from the Sun and how much energy the Earth radiates back to outer space as invisible light) and sea surface salinity are most useful for longer-term climate predictions, while other variables like air pressure and upper air wind speed and direction are useful for short-term weather predictions. Currently measurements of ECV's are carried out by various bodies in Ireland including Met Éireann, the Marine Institute, OPW, Teagasc and the EPA.

In Ireland, a series of reports have provided analysis of observational data, e.g. Sweeney et al (2002), McElwain et al (2007), Nolan et al (2010) and Dwyer (2012 in preparation). These analyses show that Ireland's climate is changing in line with regional and global observations.

Observational data are also provided by satellite systems. These provide wider spatial detail which complements the in-situ observations. The EU Global Monitoring for Environment and Security[17] (GMES) is the European programme for the establishment of a European capacity for Earth Observation, one of the aims of which is to enhance the contribution of satellite observation systems to addressing climate change.

2.2.2 Other Research Institutions

There are also a number of other Government bodies and academic institutions carrying out research on climate change issues and adaptation. Examples include:

[16] http://www.wmo.int/pages/prog/gcos/

[17] http://ec.europa.eu/enterprise/policies/space/gmes/

- The OPW has recently completed a *Strategic Review of Options for Flood Forecasting and Flood Warning in Ireland* following consultations with key stakeholders.

- In addition, the OPW has also established a number of research programmes, some in conjunction with the primary environmental stakeholders, on flooding issues. Useful information in this regard can be found on the websites www.opw.ie/en/FloodRiskManagement/ and www.flooding.ie/en/Intheeventofaflood/.

- Under the Irish Coastal Protection Strategy Study (ICPSS), the OPW has recently prepared strategic coastal flood hazard maps for the national coastline representing two future scenarios (mid-range and high end) to the end of 2100, which take into account both future sea level rise and glacial isostatic adjustment. These future scenario coastal flood hazard maps have been issued for information and consultation to coastal local authorities are soon to be published by the OPW.

- Teagasc actively collaborates with research organisations across the world on issues relating to food security and climate change.

- The Irish Climate Analysis and Research Units (ICARUS) based in NUI Maynooth is one of a number of research institutions funded by the EPA's CCRP. ICARUS was established in order to improve scientific understanding of climate change and its impacts, with particular emphasis on Ireland. The ICARUS website can be accessed at http://icarus.nuim.ie/.

- The Coastal and Marine Research Centre (CMRC) within University College Cork is another key research centre supported by the CCRP. A list of CMRC's research work can be found at http://cmrc.ie/research-projects.html.

- The Council for Forest Research and Development (COFORD) has developed a web-based species selection tool which is available to assist managers/farmers/local authorities in selecting and forecasting tree species suitability to specific site types under future climate change scenarios. Further information can be found at www.coford.ie.

At EU level, the European Commission, through DG Research, has funded projects to enhance pan-European and Global understanding of climate change and its impacts. Groups from Ireland have been actively involved in such research e.g. the Ensembles projects which involved regional climate modelling groups from around Europe. This work, which can be explored further at http://www.ensembles-eu.org/, has contributed to the development of shared knowledge and understanding of the challenges across Europe.

Ireland is also linked to CIRCLE2 ERA-NET[18] on climate change impacts and adaptation research, a Joint Programming Initiative on climate change (JPI Climate)[19], the EU/European Space Agency (ESA) initiative on global monitoring for environment and security[20] and the Group on Earth Observations (GEO-GEOSS)[21] and the ESA Earth Observation Envelope Programme (EOEP)[22].

A selection of other research documents and tools to assist with the adaptation process is available in Annex III.

2.3 Research/Tools Being Developed

While a sizable amount of climate information currently exists for Ireland, much of this is spread out among a number of institutions and agencies. The need for a centralised information resource has been identified and initial work is already underway on the development of a pilot national climate change information system. The pilot phase of Ireland's Climate Information Platform Project (ICIP), is being developed by EPA's CCRP. It will complement the European Climate Adaptation Platform *Climate Adapt* and will be designed specifically to provide local and national level planners with the know-how and the knowledge required to integrate adaptation into their planning. The system will aim to provide information to key stakeholders working on climate change adaptation, to create awareness and understanding of climate impacts and adaptation and to understand the measures that can be taken to reduce risk. The Platform will be a key support to the implementation of this National Adaptation Framework.

The development of the platform involves a two phased approach. Phase 1 of the Platform involves the provision of an on-line resource of relevant and authoritative climate information that is specifically designed to support local and national level assessments of climate change. Phase 2, will see the functionality of the platform enhanced through the provision of greater data analysis and decision support tools.
Future work under the EPA's Climate Change Research Programme will take account of the need for adaptation indicators to assist in monitoring and reviewing of plans as well as allowing for comparison across plans.

Researchers from ICARUS are currently undertaking a number of inter-related research projects - *Co-ordination, Communication and Adaptation for Climate Change in Ireland (CoCo-Adapt) - an Integrated Approach* (see http://icarus.nuim.ie/coco-adapt). The scope of this research addresses adaptation in the water, biodiversity, governance, construction and economics sectors. The COCO-ADAPT project has been funded by the EPA's CCRP.

[18] http://www.circle-era.eu/np4/30.html
[19] http://www.jpi-climate.eu/
[20] http://www.esa.int/esaEO/SEMV343VQUD_environment_0.html
[21] http://www.earthobservations.org/index.shtml
[22] http://www.esa.int/SPECIALS/Technology/SEMMR5WPXPF_0.html

The EPA is also funding the Coastal Climate Adaptation and Development Project (CLAD). CLAD aims to build capacities and develop tools to support local communities and Irish coastal authorities in decision-making on climate adaptation. The project is expected to be completed in mid-2013.

UCD is currently grant-aided by the EPA to develop a project which will assess and identify suitable methodologies and guidelines for risk assessment and the costs and benefits associated with adaptation options. This is also due to be completed in 2013.

The challenge is to link the knowledge which already exists with policy and action. Dialogue between the climate science community and policy makers will be encouraged and quality information will be accessible to those tasked with implementing adaptation actions on the ground.

It is important that organisations involved in the development of adaptation plans access and use the tools available to them to commence the adaptation process. Annex II sets out the guiding principles for the preparation of adaptation plans and Annex III contains a list of references and links to useful tools.

It is acknowledged that the process of climate adaptation evolves over time in response to on-going assessments of impacts and vulnerabilities. There will always be an element of uncertainty to adaptation planning and decision-making. However, planning needs to start now, even if it has to be based on imperfect or incomplete information. The adaptive process is an iterative process, where plans and actions can be modified and changed as new information and research becomes available.

Summary of Actions

- The Department of Environment, Community and Local Government will continue to prioritise the filling of gaps in climate research needs and ensure that accessible information will continue to be provided to support the adaptation decision-making process. Other research work on adaptation in specific sectors is often carried out or commissioned by other Government Departments/bodies such as the OPW, Teagasc, Coford, etc. This research work will also continue to be supported and promoted by other relevant Departments.

- The Department of the Environment, Community and Local Government will continue to support the EPA in continuing to play a lead role in building the evidence base and tools to help organisations adapt to climate change.

- To promote a more consistent approach to the dissemination of adaptation research and best practice the EPA will continue to lead in the development of a web-based tool (to be known as the Climate Platform) to help stakeholders plan their own decisions on adapting to climate change. The Climate Platform will include details of all EPA funded research on adaptation and the associated findings. Other State bodies will also provide specifics of their adaptation research for publication on the Platform.

- The Department of the Environment, Community and Local Government will continue to support Met Éireann in its development of climate predictions systems and provision of climate services for Ireland. Met Éireann will integrate its efforts with European and international initiatives, within the overall co-ordination of the World Meteorological Organisation.

- The Department of Environment, Community and Local Government will also continue to support the development of enhanced national co-ordination of observation systems, under the leadership of the EPA and Met Éireann, who will, with the assistance of other responsible bodies and institutions, provide periodic update on the state of Ireland's climate system and provide useful and transferable analysis of data from this system.

3. GOVERNANCE

3.1 Adaptation Governance at UN and EU Level

Governance centres on the process of decision-making, and the implementation of decisions that are responsive to the present and future needs of society. The adaptation challenge will require individuals and communities, corporate citizens, and all levels of government pulling together to make tough decisions and lasting commitments. Policies and regulation designed centrally to deal with the impacts of climate change should therefore, provide for coherent and integrated responses to the challenge of climate adaptation. Such policies and regulations should facilitate a decentralised and devolved approach, which allows for flexible responses to local climate-related risks.

Successful implementation of adaptation policies and measures requires cross-sectoral dialogue and actions. Roles and responsibilities need to be clearly defined and understood and relevant information and research needs to be easily accessible to those charged with addressing the adaptation issue. In recognition of this, the governance dimension to climate change extends from the international and EU level down to the national and local level

At the inter-governmental level, the UNFCCC adheres to the 'precautionary principle' to reduce the adverse effects of climate change and requires the formulation and implementation of national or regional programmes containing measures to facilitate adequate adaptation to climate change. Article 4 of the UNFCCC stipulates that every effort must be made to adopt national or regional adaptation strategies. Most recently, the Cancun Adaptation Framework[23], agreed by Parties in December 2010, identifies actions that all countries should undertake to enhance action on adaptation.

The EU's 2009 White Paper on Adaptation recognised that most individual adaptation measures need to happen at local or regional level and made the case for multi-level governance in addressing climate change. The White Paper highlights the need "to promote strategies which increase the resilience to climate change of health, property and the productive functions of land, *inter alia* by improving the management of water resources and ecosystems". Building on the 2009 White Paper, the EU Adaptation Strategy, to be published in March 2013, will continue to provide a basis for exchange of good practices, mainstreaming climate adaptation into EU policies and legislation, and support for Member States with guidelines on issues of common interest. Other important EU policies, such as *the EU 2020 Strategy*[24] and the *The European Environment – State and Outlook 2010*[25], also emphasise the importance of a robust governance framework.

[23] The objective of the Cancun Adaptation Framework is to enhance action on adaptation, through international cooperation. Further information available at http://unfccc.int/adaptation/cancun_adaptation_framework/items/5852.php

[24] http://ec.europa.eu/europe2020/index_en.htm

3.2 Role of Government

Internationally, adaptation is relatively new in terms of policy development and Ireland, like many other States, is in the early stages of integrating adaptation into its policy and decision-making processes. The role of Government is to ensure that adaptation is managed in an effective manner by understanding national and local impacts, and the effect of climate change on human activity and ecosystems. This cannot be tackled at one administrative level only as the challenge necessitates a multi-level approach. Consequently, responsibility must be divided between the different levels of Government.

However, there are a number of features of climate change adaptation that may present challenges and difficulties in the implementation of effective governance mechanisms. These include the scientific uncertainty regarding the timing and magnitude of future climate change impacts, future GHG emission trajectories, and the medium-to-long-term timescales of adaptation which tend to fit poorly with a tendency to sometimes focus on issues of a shorter-term nature which may seem to be of greater urgency.

In the context of uncertainty, international research has highlighted the potential for strategies that are robust to uncertainty. Robust strategies have been generally defined as those that: -

- are *low-regret,* in that they are functional and provide societal benefits under a wide range of climate scenarios,
- are *reversible*, in that they keep the cost of being wrong to a minimum,
- provide *safety margins* that allow for climate change in the design of current infrastructure or easy retro-fitting,
- use *soft strategies* that avoid the need for expensive engineering and institutionalise a long-term perspective in planning for climate resilience,
- reduce the *decision time horizons* of investments, and
- are *flexible* and mindful of actions being taken by others to either mitigate or adapt to climate change.

3.3 Policy Coherence

The Government already plays a clear and central role in key areas affected by climate change either because of the public nature of the services it provides, or through the formulation of policies and associated legislation. Given the wide-ranging nature of this involvement, it will generally be more efficient to embed adaptation considerations into the existing institutions and practices in a systematic way, and

[25] http://www.eea.europa.eu/soer

correct for any existing regulatory inefficiencies which risk being exacerbated by climate change.

Strong policy and planning co-ordination among Government Departments and local authorities will be crucial in the delivery of this Adaptation Framework, and the forthcoming EU Adaptation Strategy where issues of national competence arise. The adaptation challenge cuts across key economic sectors and consequently, a wide range of policy areas. To be addressed successfully, and as cost effectively as possible, adaptation issues and priorities must be integrated across the full breadth of economic and development decision-making.

One of the main barriers for successful adaptation is the unclear definition and delineation of responsibilities of the different authorities and stakeholders. Collectively, the Government is committed to providing clear leadership in promoting a coherent approach to climate change adaptation between the different levels of Government from national to local. Its role, therefore, is to ensure that all stakeholders, including Government Departments and Agencies, local authorities and statutory undertakers, are aware of the importance of taking action to adapt to the impacts of climate change and act accordingly on foot of this. The need to promote mainstreaming of climate change adaptation across governance frameworks and institutions will be reflected in any future legislative changes to underpin national climate change policy.

Civil society organisations also have a role to play, through reinforcing the message to the public about the need for climate adaptation, engaging in the adaptation debate, and enhancing linkages between scientific research and policy making.

Each relevant Minister will promote an institutional environment, for their sector, that enables organisations and individuals to make effective and efficient adaptation decisions. They will consider how the outcomes of existing programmes and policies will be affected by climate change; and whether existing programmes, policies and regulatory frameworks either facilitate or hamper adaptation.

As outlined in 3.4 below, the Department of the Environment, Community and Local Government will lead and co-ordinate national adaptation policy and the implementation of this Framework, working as appropriate through the Cabinet Committee system, to ensure overall policy coherence and effective communication across Departments and Agencies, particularly where there are cross-cutting issues within sectoral adaptation plans.

The aim of this Framework is to ensure that an effective role is played by all policy and decision makers in bringing about a pro-active adaptation policy regime that can be maintained and updated as policy circumstances evolve. This multi-level governance approach will involve:

- the preparation of periodic reports on adaptation and anticipated long-range adaptation costs as well as avoided damages;

- engagement with key stakeholders to explore impacts and responses;
- collaboration with the insurance industry to identify vulnerabilities and take remedial action;
- the integration of climate adaptation into planning for protected areas, and in agriculture and natural resource management plans;
- procedures and capacity to undertake emergency response measures when extreme weather events occur; and
- continued research on climate change impacts.

3.4 Role of the Department of the Environment, Community and Local Government

The Department of the Environment, Community and Local Government will lead and co-ordinate national adaptation policy and the implementation of this Framework, working as appropriate through the Cabinet Committee system. The Department will also support co-ordination and integration at local level.

In addition to co-ordinating the national framework, the Department will be responsible for disseminating information on climate adaptation developments at EU level, including reporting on measures agreed at the Informal Adaptation Steering Group[26]. Furthermore, as Ireland's representative in the UNFCCC process, the Department and its national climate delegation will continue to report on global developments on adaptation arising on the wider international stage.

Met Éireann will continue its activities in climate research, the prediction of the future Irish climate for the coming decades and climate services.

3.5 Role of other Ministers and Government Departments

As highlighted by the Organisation for Economic Co-operation and Development (OECD)[27] effective integration of adaptation requires strong co-ordination of adaptation from centres of power at national level. A critical role for Ministers is to take a leadership role in implementing this Framework by mandating and pushing adaptation planning and implementation within their own areas, through their Departments and relevant Agencies. Each relevant Minister will lead by example

[26] An Adaptation Steering Group (ASG) was created in September 2010 to assist the Commission in developing its approach to dealing with adaptation. The Steering Group brings together Member States and a diverse range of stakeholders. It contributes to the preparatory work of the Adaptation Strategy. Officials from the Department of Environment, Community and Local Government attend the meetings.

[27] The OECD provides a forum in which governments can work together to share experiences and seek solutions to common problems. The organisations works with governments to understand what drives economic, social and environmental change. See http://www.oecd.org/about/

and prepare for the impacts of climate change by determining how to integrate climate adaptation into relevant policies and measures within their remit. This will be done by engaging with key players in their respective sectors; championing adaptation policies and instruments; and encouraging the private sector and civil society to partake in the adaptation process. Other aspects of adaptation such as major infrastructural decisions will require greater foresight and planning. .

3.6 Role of the EPA

In order to help all players involved in implementing this Framework better understand their respective role in addressing climate change, the Government will ensure that easy access to necessary information and tools will continue to be provided. The EPA has taken on a lead role in building the evidence base and tools to help organisations understand and adapt to climate change, and will continue to provide advice and support to key sectors to help them build resilience to climate change, informed by the outputs from its research programme.

3.7 Role of the Wider Public Sector

Organisations with a public service mission will have varying degrees of influence in relation to adaptation, depending on their particular roles, functions, and responsibilities. However, all public bodies need to ensure their resilience to future climate impacts and to plan for business continuity in relation to their overall functions and the services they deliver to the wider community.

Senior management in public bodies must consider now the risks, challenges and opportunities that climate change presents to their business continuity and how, in delivering their functions, they may build broader resilience to climate change through adaptation, using available tools and information. This is vital given that decisions and investments made by public bodies today will have an impact for decades to come.

Public bodies should engage directly with others that are influenced by their policy decisions and should, where appropriate, aim to embed climate adaptation considerations into key areas of work, such as investment in infrastructure and the procurement of goods and services. Some public bodies such as Forfás and the Heritage Council/Fáilte Ireland have already engaged in trying to identify the extent, significance and vulnerability of climate change on their sector and how they will plan for the future. Other public bodies should follow suit and work with stakeholders to enable vulnerabilities to be managed and allow opportunities for their sector to be exploited.

This Framework mandates the relevant Government Departments and other public sector bodies to prepare sectoral adaptation plans; this is explored further in Chapter 4.

3.8 Role of Local Authorities

Climate change impacts will often be most evident at the local level and will require, in parallel with sectoral adaptation planning, locally tailored policies and responses. Through their role as community leaders and service providers, local authorities have an essential role to play in planning ahead and taking climate change adaptation action.

The changing climate will present different challenges in each area, based on their vulnerability to climate risk and their capacity to adapt. A pro-active approach in which the challenges posed by climate change are integrated into the development of policies, plans and programmes is essential. Chapter 5 of this Framework provides for local authorities to prepare local adaptation plans through the development plan review process. The Government will support and facilitate this approach through the preparation of guidelines, and through on-going support for research to develop the knowledge base at national and local level.

Local authorities are subject to increasing demand from many quarters to improve services and overall performance. In developing adaptation plans, many local authorities will face similar challenges and adaptation matters to be addressed may have implications for their neighboring local authority areas and may require solutions that stretch beyond their individual administrative areas. Therefore, in developing and analysing potential climate impacts and adaptive solutions, local authorities may opt to take a broader geographical or regional approach in preparing adaptation plans by working with adjoining local authorities. Working together can also be a practical and cost-effective way for local authorities to share knowledge, experience and resources or to take advantage of economies of scale.

Summary of Actions

- Individual Ministers will take responsibility for adaptation in their respective sector(s) for which they have responsibility.

- The Department of the Environment, Community, and Local Government will lead and co-ordinate on international, EU and national climate adaptation policy, working as appropriate through the Cabinet Sub Committee system.. It will support and promote innovative policymaking on climate adaptation at all levels, and support strategic decision-making on how best to address the impacts of climate change.

- The Department of the Environment, Community, and Local Government will support implementation of the Framework by local authorities.

- Public bodies will engage directly with others that are influenced by their policy decisions and embed adaptation as necessary into key areas of work such as investment in infrastructure, and the procurement of goods and services.

- Local authorities will take a proactive approach to climate change adaptation by integrating adaptation into the development of relevant policies, plans and programmes.

4. SECTORAL PLANS

Government Departments, Agencies and other public bodies will lead the way in ensuring that adaptation measures are mainstreamed into their programmes and policies through the development of appropriate sectoral adaptation plans. Adaptation measures must be built on planning ahead rather than paying for consequences. Organisations that are responsible for important services and infrastructure must begin to assess the risks posed by climate change and their vulnerabilities to climate change as part of the normal development process and accordingly make the necessary plans to counter or deal with the effects. In so doing, robust adaptation decisions can be made, avoiding costly retrofits or the abandonment of infrastructure before the end of its otherwise useful life.

Measures to address adaptation must be comprehensive, have a long-term perspective, and take cognisance of other sectors, levels of governance and national, EU, and international policies. Some adaptation measures and process are evident in most sectors (Desmond and Shine, 2011); however, they appear to be undertaken on an ad-hoc basis normally triggered by changes that require immediate response, rather than developed to deal with emerging or future risks and change predictions.

4.1 Climate Sensitive Sectors

Key climate-sensitive sectors include water, marine, agriculture, forestry, biodiversity, energy, transport, communications, insurance, heritage and health. Annex IV gives a brief overview of the challenges in the context of climate change impacts and vulnerabilities for each of the most sensitive sectors. For these sectors, the integration or mainstreaming of climate change considerations into key decision-making processes is the most effective response. The main players best placed to address this at Government level are line Departments and Agencies under their aegis.

4.2 Essential Elements of Sectoral Plans

Each relevant Government Department (or State Agency, where appropriate) will prepare adaptation plans for their sectors, each of which must be approved by the relevant Minister. Draft sectoral plans will be published by mid-2014 and will be based primarily on sectoral risk assessments. The process for preparation of these draft sectoral plans will allow for input from all relevant stakeholders, particularly those bodies who will be expected to play a key part in implementing the plans. In preparing these sectoral plans, due account will also need to be taken of the requirements of the EU Strategic Environmental Assessment and Habitats Directives.

As a minimum, these plans will present evidence of a clear understanding and description of the risks presented by climate change to the sector, their vulnerability to such risks and actions both to address the risks and ensure the climate resilience of the sectors. Government Departments may also direct bodies under their aegis to draw up adaptation plans for specific areas of responsibility, where warranted.

In drawing up these sectoral plans, three basic steps must be reflected:

- a clear understanding of the consequences of a changing climate for each sector;
- actions to equip decision-makers with skills and tools; and
- the integration of adaptation into policy and administration at sectoral level in Ireland.

The table at Figure 6 below lists the Government Departments responsible for and required to produce adaptation plans for the key sectors by mid-2014. Recommended guiding principles for the preparation of adaptation plans are listed in Annex II, while Annex III contains a list of references and links to useful tools.

As indicated earlier in this Framework, the process of climate adaptation evolves over time in response to on-going assessments of impacts and vulnerabilities Adaptation planning is therefore an iterative process, where plans and actions can be modified and changed as new information and research becomes available. Accordingly, it is envisaged that sectoral plans will be reviewed and updated at least every 5 years: however, where a sectoral mitigation plan is required under the forthcoming primary legislation on climate change, both the mitigation and adaptation elements of these sectoral plans should be reviewed in tandem to ensure full coherence of analysis and actions.

4.3 Stakeholder Engagement

The process of making sectoral adaptation plans must be open, transparent, and inclusive. Interested organisations and stakeholders, at sectoral and national levels, must be given early and adequate opportunity to input to the process of preparing the plans.

Policy decisions taken at sectoral level directly affect activities within the individual sector, and, potentially, may also affect other sectors indirectly. Therefore, cross-sector engagement must often occur as part of the adaptation process to ensure that interdependencies are understood and effectively considered in policy and planning processes. Sectoral level decision making will also cut across local-level decision-making and this too must be taken into account.

The Government acknowledges the importance of complementary private sector action to address the impacts of climate change. The private sector, in particular the insurance sector, has a wealth of experience in quantifying, pricing, reducing and

managing weather-related risks across sectors and areas. In partnership with Government, it can therefore play an important role in collecting and disseminating data on weather and catastrophe risk, financing risk assessments, and supporting the design and provision of insurance schemes.

Each Minister and State Agency, where appropriate, will seek to engage with private sector representatives for their respective sector/area in shaping and developing their adaptation plans.

Figure 6: Lead Departments and Agencies for Sectoral Adaptation Plans

Sector Level	Lead Department for Sectoral Adaptation Plans
Water	Department of Environment, Community and Local Government
Emergency Planning	
Marine	Department of Agriculture, Food and the Marine
Agriculture	
Forestry	
Biodiversity	Department of Arts, Heritage and the Gaeltacht
Heritage	
Transport	Department of Transport, Tourism and Sport
Energy	Department of Communications, Energy and Natural Resources
Communications	
Flood Defence	Office of Public Works
Health	Department of Health

Summary of Actions

- Each relevant Government Department (or State Agency, where appropriate) will prepare adaptation plans for their sectors.

- Draft sectoral plans, based on sectoral risk assessments, and following consultation with relevant stakeholders, to be published, by mid-2014 and adopted as quickly as possible thereafter.

- Government Departments and bodies will adopt an open, transparent, and inclusive approach to sectoral adaptation planning, with interested organisations and stakeholders being given early and adequate opportunity to input to the process of preparing adaptation plans.

- Each relevant Minister will foster a co-operative relationship with the private sector, and in particular the insurance sector, for the collection and dissemination of data on weather and catastrophe risk.

5. LOCAL ADAPTATION PLANS

5.1 Local Authorities

Local authorities play a pivotal role in planning for, and responding to, emergency situations. Given their close relationship with the community, local authorities can respond faster and more effectively to local climate events than other government organisations. They possess up-to-date knowledge of the local natural and man-made environment and, therefore, have a critical role to play in managing climate risks and vulnerabilities. Building resilience to the impacts of climate at a local level for communities and businesses can be achieved in an effective manner if it is integrated into existing planning frameworks.

One of the greatest challenges for local authorities in preparing to adapt to climate change is building the organisational capacity to adapt to the impacts of climate change. This will require 1) an assessment of climate risk, and 2) the development of adaptive capacity (which can include organisational capacity, resources, and awareness/know-how).

The County and City Managers Association (CCMA) have clearly recognised the key role that local authorities play in implementing climate change responses. Fulfilling that role requires adaptation to be embedded in key local authority functions including the planning process, the provision of local infrastructure, the implementation of building control and the co-ordination emergency planning. Actions already taken by some local authorities, such as the *Climate Change Strategy for Dublin City 2008-2012*[28] produced by Dublin City Council, is encouraging and welcome. Building on these proactive steps, this Adaptation Framework aims to bring a consistent and coherent approach to adaptation planning at a local level. The CCMA will play an important role in facilitating the exchange of best practice in the development and implementation of climate adaptation policy at local government level, fostering a shared approach to managing the impacts of climate change.

Local adaptation strategies need to develop and express a vision for a well-adapted local community that is resilient to the impacts of climate change, through:

- determining an area's vulnerability to climate risks;
- identifying, prioritising and costing adaptation actions;
- developing and implementing a comprehensive action plan; and
- ensuring that climate change impacts and risks are embedded into all decision-making.

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http://www.dublincity.ie/WATERWASTEENVIRONMENT/SUSTAINABILITY/Pages/TheClimateChangeStrategyForDublinCity2008-2012.aspx

Local authorities may opt to collaborate with adjoining local authorities in the preparation of adaptation plans. This may occur in cases where it provides for more effective implementation of climate adaptation measures or where cross county boundary issues arise.

The spatial planning process, with full engagement of key stakeholders, provides an established means through which to implement and integrate climate change objectives, including adaptation, at local level. This Framework gives the mandate to local authorities to prepare, review and amend local development plans to mainstream climate change adaptation as this is the most appropriate way to effect local adaptation planning.

5.2 Spatial Planning

The planning process plays a very important role in factoring climate change into physical and spatial development and further practical guidance will be developed building on establishing best practice.

The *2002 National Spatial Strategy*[29] (NSS) is the overarching national strategic planning policy framework for the State over the period to 2020 and is founded on the principles of sustainable development. The spatial planning process provides great potential to implement and integrate climate change objectives, particularly at the regional and local level (Desmond and Shine, 2011). In this regard, the national focus of the NSS is complemented by Regional Planning Guidelines, Development Plans and Local Area Plans in providing an integrated hierarchy of spatial plans for Ireland.

Taking account of changed circumstances since the NSS was published in 2002, the *National Spatial Strategy Update and Outlook Report*[30](2010) highlighted the need to support the emergence of much more economically, socially and environmentally sustainable patterns of development by tackling the drivers for urban sprawl, maximising the opportunities to reduce CO_2 emissions and fossil fuel energy use, while adapting to the emerging effects of climate change and protecting the qualities of our groundwater, rivers, habitats and heritage.

The review of Regional Planning Guidelines in 2010 and the incorporation of Core Strategies in City and County Development Plans, which took place on foot of the *Planning and Development (Amendment) Act 2010*[31] and the 2010 *Update and Outlook Report,* have collectively further extended the approach of the NSS, affecting the approach to the location and quantum of land zoned for future development.

[29] http://www.irishspatialstrategy.ie/

[30] http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/NationalSpatialStrategy/FileDownLoad,24144,en.pdf

[31] http://www.irishstatutebook.ie/pdf/2010/en.act.2010.0030.PDF

Over time, the approach above will bring about more compact and less energy-intensive forms of urban development and assist in adapting to climate change effects such as flood risk.

5.3 Development Plans and Local Adaptation Planning

Notwithstanding the progress being made at a national level, further advances are required to improve the process of preparing statutory development plans with regard to the inclusion of practical measures to address both the drivers and side effects of climate change. These improvements will build upon recent innovations under the *Planning and Development (Amendment) Act 2010* which require development plans to contain an additional mandatory objective for the promotion of sustainable settlement and transportation strategies in urban and rural areas, including the promotion of measures to reduce energy demand, man-made greenhouse gas emissions and address the necessity for adaptation to climate change, having regard to location, layout and design of new development. This can be regarded as a mandatory objective on climate change.

There is much established good practice on integrating climate change considerations into development plans. For example, the aforementioned Dublin City Council *Climate Strategy for Dublin 2008 – 2012* includes a high-level objective to 'climate change-proof the Dublin City Development Plan and other plans, studies, policy documents' and the Dublin City Development Plan contains many provisions addressing both adaptation and mitigation issues.

Further guidance will be developed to inform a stronger, clearer process of climate change-proofing development plan (and local area plan) objectives, embracing both mitigation (such as green building measures or delivery of more compact, less carbon-intensive forms of development) and adaptation measures (such as flood risk assessment and management) across the major elements of such plans, including, inter alia:

- the core strategy (addressing urban and rural settlement patterns) and zoning;
- physical and social infrastructure provision;
- development standards; and
- natural and built heritage.

In the absence of reliable quantitative modelling techniques to profile the carbon intensity of different planning scenarios, which may become available over time, effective checklists will be developed to assist planning authorities in ensuring that their plans address climate issues, particularly in relation to adaptation.

The Government will support and facilitate the approach above by updating the statutory *Planning Guidelines on Development Plans* (2007)[32] published by the Minister for the Environment, Community and Local Government under Section 28 of the Planning and Development Act and the *Guidelines on Strategic Environmental Assessment*[33]. The updating of the Development Plan Guidelines will commence in 2013 and the Strategic Environmental Assessment Guidelines in 2014. Such updated guidance will draw upon current research underway by the EPA under its research programme.

5.4 Delivery of Local Adaptation Planning

At an administrative and technical level, local authorities will be required to make an immediate assessment, of the extent to which their existing development plans adequately address the challenges of adaptation to climate change and will aim, where appropriate, to have a review of their development plan underway by mid-2014 (if necessary, through amendment and variation procedures) in order to integrate climate change adaptation into development planning. In this manner, development plans will, in effect, become the mechanism for the delivery of local adaptation action.

Thereafter, as local authorities review their development plans in the normal cycle, climate change adaptation (as well as mitigation) considerations will be mainstreamed into the process; the local development plan will also be the 'de facto' local adaptation plan.

5.5 Stakeholder Engagement at Local Level

The involvement of key stakeholders at local level in the preparation of local adaptation plans is essential and the development plan process provides a mechanism for effective engagement. Its open, transparent and inclusive characteristics will ensure that opportunities are provided for all interested individuals and organisations at local, regional and national levels to comment or make submissions for consideration before the policies, objectives and measures to be included in the plan are decided upon.

[32] http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/FileDownLoad,14468,en.pdf

[33] http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/FileDownLoad,1616,en.pdf

Summary of Actions:

- In supporting local communities, local authorities must consider the issue of climate adaptation in the delivery of its services and infrastructure.

- As local authorities review their city and county development plans they should integrate climate change adaptation (as well as mitigation) considerations into their statutory plans.

- Local authorities should aim to have the review process of their development plans underway by mid- 2014 (if necessary through amendment and variation procedures) to include climate change adaptation if this is not already adequately addressed. As part of this process, local authorities will continue to collect evidence, raise awareness, and create the necessary relationships and actions needed to deliver purposeful adaptation measures.

- The Department of Environment, Community and Local Government will support and facilitate this approach in the preparation of guidelines for integrating climate adaptation into development plans as well as guidance on adaptation proofing of Strategic Environmental Assessment.

- The City and County Managers Association (CCMA) will play an advisory role and facilitate the exchange of best practice in the implementation and development of climate adaptation policy at local level, fostering a shared approach to managing the impacts of climate change.

- Local authorities will continue to consult and encourage partnership with stakeholders when addressing adaptation matters at a local level, particularly through the open and participative process for making development plans, into which local adaptation planning is to be integrated.

6. NEXT STEPS

6.1 Enabling a Comprehensive Policy Response to Climate Change Adaptation

Work on adapting to our changing climate is already well underway – either as a process of specific adaptation or relevant work that is being carried out for other purposes not necessarily under the banner of "adaptation". The challenge now is to ensure that these actions are complementary and that they all come together to ensure that Ireland is as prepared as possible to manage the impacts of climate change and make the most of the opportunities that are likely to arise.

Enough high quality data and information exists to begin and inform the adaptation planning process now. Sufficient information sharing and dissemination systems are being developed which can be used to inform many levels of decision-making.

This National Climate Change Adaptation Framework is designed to provide a strategic policy focus across all tiers of Government to ensure adaptation measures are taken across different sectors and levels of governance to reduce Ireland's vulnerability to the impacts of climate change. Similar to the approach being taken by the EU in its *White Paper on Adaptation*, which will be further elaborated in the EU Adaptation Strategy to be published in Spring 2013, it is proposed that Ireland's framework follows a two-phase approach to adaptation.

Phase 1 - which is already well underway, is focused on increasing our understanding of the impacts and national vulnerabilities associated with climate change. A substantial amount of information already exists, including the EPA's report *A Summary of the State of Knowledge on Climate Change Impacts for Ireland* and research undertaken by, for example, ICARUS, CMRC and UCD through the EPA's Climate Change Research Programme. Other tools and research supports are still being developed but will be completed shortly, e.g., Ireland's Climate Information Platform Project (ICIP) which will provide a forum for knowledge exchange and capacity building by centralising existing climatic information and data for Ireland.

Phase 2 - will focus on the development and implementation of sectoral and local adaptation action plans which will form the key pillars of the comprehensive national response to climate change adaptation. The plans will be informed by the outcome of Phase 1, including DECLG/EPA guidelines on the development of local adaptation plans and the web-based Climate Platform resource tool, as well as a number of other resource tools, and will build on the progress made in terms of awareness and integration. However, while work on Phase 1 is already well advanced, commencement of work in Phase 2 is not dependent on completion of work in phase one and so can begin immediately.

6.2 Format and Process for Sectoral and Local Adaptation Plans

Sectoral – these plans will be prepared by the relevant Department or Agency and will be adopted by the relevant Minister. Draft sectoral plans will be published by mid-2014 and will be based on sectoral risk assessments. The process for preparation of draft sectoral plans will allow for input from all relevant stakeholders and will ensure that the most cost effective measures are identified by policy makers and practitioners in each field. Representative bodies and sectoral agencies will be important stakeholders at this level.

Local – The changing climate will present different challenges to each local authority, based on their vulnerability to climate risk and their capacity to adapt. A pro-active approach to addressing the challenges posed by climate change would involve preparing for projected impacts and integrating appropriate responses into the development of policies, plans and programmes. The spatial planning process provides an appropriate framework to implement and integrate climate change objectives.

As local authorities review their development plans they will integrate climate change adaptation (as well as mitigation) considerations. As a first step, local authorities will make an assessment of the extent to which existing development plans adequately address the challenges of adaptation to climate change and, where appropriate, aim to have a review process of their development plan underway by mid-2014 (if necessary through amendment and variation procedures where their city/county development plan is in mid-cycle).

6.3 Review of Plans and Reporting

Adaptation plans will need to be updated and refined over time as more data on impacts becomes available and as experience of dealing with adaptation issues increases. While uncertainty is an issue that will affect decision-making in the short term, it cannot be allowed to prevent early planning and action to prepare for a changing climate. Given how new the area of adaptation planning is and the level of uncertainty under which adaptive actions take place, it is essential that adequate monitoring and review mechanisms are put in place at sectoral and local levels.

Sectoral adaptation plans should be revised at least every 5 years, except in cases where a mitigation plan is required under forthcoming primary legislation on climate change: in such cases both mitigation and adaptation plans can be reviewed in tandem. The review of local plans should be in line with the cycle of development plan review under the planning and development legislative code (i.e. every six years). The review of sectoral and local plans is important because adaptation is a long-term process that will allow us to develop our capacity over time. Each new plan

will build upon experience gained as a result of the development and implementation of the previous plan will be informed by others experience and expertise and will take account of the outcomes of on-going research and policy development. Plans and the outcomes of plans at other levels of governance will also provide a source of information to enrich and improve each new plan.

In order to ensure effective monitoring and review, it is important that adaptation plans identify who will be responsible for monitoring the plan, the criteria against which plans should be reviewed, the review process and the timescales for reviews to take place. Future work under the EPA's *Climate Change Research Programme* will take account of the need for adaptation indicators to assist in monitoring and review of plans as well as allowing for comparison across plans. This will also assist in the national reporting requirements arising from UNFCCC obligations and potential future EU reporting requirements. The Government's priority is to ensure that Ireland will take the necessary actions on adaptation to climate change to protect its people, economy and environment and that these are accurately reflected in international and EU reporting requirements that may arise.

Ireland is currently required under the UNFCCC to submit National Communications at regular intervals. These reports provide information on emissions and removals of GHGs, policies and measures to address emissions, actions on adaptation, as well as research, systematic observations, education and awareness raising and other activities being undertaken to implement the Convention. From 2014, biennial reports will also be required, in order to fill the information gap between National Communications. Further reporting on adaptation may be required under new requirements being considered at EU level.

6.4 Risk Assessment

Risk assessment will be a vital part of planning for adaptation. Once assessed, plans and measures can be designed to manage those risks.

Ministers must ensure that all critical infrastructure investments undergo a prior risk assessment so that they are "disaster-proofed", as far as practicable. This will require monitoring and controlling the specifications and standards used in major projects and critical infrastructures, in order to ensure that adaptation to the effects of future climate change is taken into account. In addition to Government Departments and public bodies, this process will require private owners and operators of critical infrastructure to also carry out assessments on the risks posed by climate change and develop strategies to respond to these risks.

6.5 Financing

Funding adaptation is complex and challenging. While adaptation measures will by their nature require some expenditure, how much that might be, the benefits accruing from such expenditure and the extent to which expenditures will fall to be funded from public versus private sources, will vary across sectors and areas.

It has been clearly demonstrated by the Stern report[34] that the cost of inaction far exceeds the cost of action (up to four times higher for damage caused by sea-level rise over that resulting if additional flood defences in place) and that this cost differential will rise steeply with time. In other words, early action is imperative, where robust risk assessments are available, to anticipate potential damage and hence plan and implement action to minimise threats to ecosystems, human health, economic development, property and infrastructure. Such early action would be more cost-effective than reactive unplanned adaptation after the event.

The OECD in its report, *Economic Aspects of Adaptation to Climate Change; costs benefits and policy instruments*[35], demonstrated that in certain sectors, some adaptation actions can lead to high benefit-cost ratios and/or can be implemented at low cost. This is particularly true for behavioural adaptations, such as water use efficiency, which have initial low costs with significant benefits. Hard engineering solutions will inevitably come at a higher initial cost and with long-term benefits and should be linked to opportunities to advance mitigation options.

The recent EEA report 'Climate Change, impacts and vulnerability in Europe in 2012'[36] signalled that potentially large damage costs are projected for Europe due to the combined impacts of socio-economic developments and climate change, although estimates of total costs of future climate change on the European economy are currently not available. However, damages from extreme weather events have increased from nine billion euro in the 1980's to thirteen billion euros in the 2000's. The EEA however, also signalled that reductions in damage costs can be achieved by global and European mitigation policies in combination with adaptation actions. To provide for a long term sustainable future in Ireland, both economically and environmentally, pro-active engagement in the adaptation process and implementing the necessary climate adaptation actions will be essential.

The public expenditure implications of climate adaptation will become clearer when sectoral and local adaptation plans are finalised. Such expenditure will fall to be met through appropriate prioritisation by Departments and agencies from within the overall public expenditure envelopes agreed by Government. The extent to which

[34] http://webarchive.nationalarchives.gov.uk/+/http:/www.hm-treasury.gov.uk/sternreview_index.htm
[35] http://www.oecd.org/document/2/0,3746,en_2649_34361_40691458_1_1_1_1,00.html
[36] www.eea.europa.eu/publications/eea_report_**2008**_4

the final 2014-2020 EU Multi-Annual Financial Framework provides for the integration and mainstreaming of climate action across key funding programmes may also provide opportunities to access funding for certain climate adaptation actions

Summary of Actions

- Sectoral adaptation plans should be revised and updated at least every 5 years. However, where a sectoral mitigation plan is required under the proposed National Low Carbon Development Bill, both mitigation and adaptation plans should be reviewed in tandem.

- Once adopted, local plans will be reviewed thereafter in line with the cycle of development plan review under the planning and development legislative code.

- Future work under the EPA's Climate Change Research Programme will take account of the need for adaptation indicators to assist in monitoring and reviewing of plans as well as allowing for comparison across plans.

ANNEX I

GLOSSARY

Adaptation can be defined as any adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007)

Adaptive Capacity is the ability of a system to adjust to *climate change* (including *climate variability* and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2001)

Climate Change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer.

Greenhouse Gas (GHG) is any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride (UNFCCC glossaries)

Mainstreaming adaptation is the integration of adaptation objectives, strategies, policies, measures or operations such that they become part of the national and regional development policies, processes, and budgets at all levels and stages (UNDP, 2005)

Maladaptation: is defined as business-as-usual development, which by overlooking climate change impacts inadvertently increases exposure and/or vulnerability to climate change. Maladaptation could also include actions undertaken to adapt to climate impacts that do not succeed in reducing vulnerability but increase it instead (OECD, 2009).

Mitigation can be defined as an anthropogenic intervention to reduce the anthropogenic forcing in the climate system; it includes strategies to reduce GHG sources and emission and enhancing greenhouse sinks (IPCC, 2007)

Resilience is a capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.

Vulnerability can be defined as the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity. (IPCC, 2007)

Acronyms and Abbreviations

AR4	Fourth Assessment Report (Intergovernmental Panel on Climate Change)
C41	Community Climate Change Consortium for Ireland
CCMA	City and County Managers Associations
CCRP	Climate Change Research Programme (EPA)
CLAD	Coastal Climate Adaptation and Development
Climate Adapt	EU Clearing House Mechanism (EU web based platform)
CMRC	Coastal and Marine Research Centre
CO-CO Adapt	Co-ordination, Communication and Adaptation for Climate Change in Ireland
COFORD	Council for Forest Research and Development
ECV	Essential Climate Variables
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ESA	European Space Agency
GCOS	Global Climate Observation System
GMES	Global Monitoring for Environment and Security
ICARUS	Irish Climate Analysis and Research Units
ICIP	Irelands Climate Information Platform
IPCC	Intergovernmental Panel on Climate Change
NAC	National Adaptive Capacity
OECD	Organisation for Economic Co-operation and Development
OPW	Office of Public Works
RSO	Research and Systematic Observations
SEA	Strategic Environmental Assessment
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organisation
WRI	World Resources Institute

ANNEX II

GUIDING PRINCIPLES FOR ADAPTATION PLANNING

Good adaptation is based on good information and communication and an understanding of:

1. The objectives of the process.
2. Adaptation measures including feasibility.
3. A desire for successful and appropriate adaptation.

There are many tools and resources available to assist in the adaptation planning process and these are set out in Annex III. A series of common series of steps that could be taken when preparing an adaptation plan are set out below:

1. Examine available research.
2. Identify the impacts for specific area/sector.
3. Identify vulnerabilities
4. Identify potential risks/opportunities
5. Identify what is required to mitigate risks and grasp opportunities
6. Identify level of planning/financing/implementation is required in the short/medium/long term?
7. Identify any co-benefits and risks associated with identified actions, taking specific care to avoid mal-adaptation or any increase in greenhouse gas emissions.
8. Identify linked sectors/areas and potential for synergies or joint or coordinated efforts.
9. Specify the measures and time frames for actions.
10. Identify measures that may be required at other levels of governance to support actions or measures.
11. Set out plans for review.

ANNEX III

AVAILABLE RESOURCES AND TOOLS

EU POLICY PAPER ON ADAPTATION

'Adapting to climate change: Towards a European framework for action '
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF

NATIONAL POLICIES

Some of the relevant national policies that set the context for adaptation action plans and that should be taken into account include:

- National Development Plan 2007-2013
- Our Sustainable Future; A Framework for Sustainable Development for Ireland
- National Climate Change Strategy 2007-2012
- Review of National Climate Policy 2011
- National Energy Efficiency Action Plan 2009 -2020
- Maximising Irelands Energy Efficiency. National Renewable Energy Action Plan 2009 -2020
- Strategy for Renewable Energy 2012-2020
- National Spatial Strategy 2002-2020
- Actions for Biodiversity 2011-2016', Ireland's 2nd National Biodiversity Plan
- Delivering Homes – Sustaining Communities
- Smarter Travel - A Sustainable Transport Future. A New Transport Policy for Ireland 2009 – 2020
- National Action Plan for Social Inclusion 2007-2016
- Food Harvest 2020
- Government Policy on Architecture 2009 -2015
- Green Tenders – An Action Plan on Green Public Procurement
- OPW - Report of the Flood Policy Review Group

USEFUL EPA PUBLICATIONS

Ireland Adapts to Climate Change
CCRP Report 9- Tara Shine and Margaret Desmond

Integrating Climate Change Adaptation into Sectoral Policies in Ireland
CCRP Report 10- Margaret Desmond and Tara Shine

A Summary of the State of Knowledge on Climate Change Impacts for Ireland
CCRP Report 1 - Margaret Desmond et al.

CLIMATE CHANGE: Refining the Impacts for Ireland
STRIVE Report 12 - Sweeney J et al.

Robust Adaptation to Climate Change in the Water Sector in Ireland
CCRP Report 16- Julia Hall, Conor Murphy and John Sweeney

Barriers to Sustainable Transport in Ireland
CCRP Report 7 - David Browne, Brian Caulfield and Margaret O'Mahony

CCRP 14: Strategy Guide on Climate Change Implications and Strategies for the Community Sector
Kevin Murphy, Ann Irwin and Tadhg O'Mahony

An Assessment of Uncertainties in Climate Modelling at the Regional Scale: The Development of Probabilistic Based Climate Scenarios for Ireland
STRIVE Report 48 - Rowan Fealy

Extreme weather, climate and natural disasters in Ireland
CCRP Report 5 - G. Kiely et al.

Current Status and Required Actions for National Climate Observing Systems
ERC Report 14 - Ned Dwyer

Ireland in a Warmer World - Scientific Predictions of the Irish Climate in the Twenty-First Century
STRIVE Report 27 - S. Dunne et al.

Climate Change Indicators For Ireland
ERTDI Report 2 - Sweeney et al.

Climate Change - Implementation of the Global Climate Observing System in Ireland
Environmental Research Centre - ERC Report 8 - N. Dwyer

Key Meteorological Indicators of Climate Change in Ireland
Environmental Research Centre - ERC Report 6 - L. McElwain and J. Sweeney

Climate Change: Scenarios and Impacts for Ireland
ERTDI Report 15 - Sweeney et al.

OTHER USEFUL PUBLICATIONS

Forfás Adaptation to Climate Change: Issues for Business.
http://www.forfas.ie/media/Adaptation%20to%20Climate%20Change%20Summary%20Report%20ONLINE%20FINAL.pdf

Climate Change Heritage and Tourism Implications for Ireland's coast and Inland Waterways.
http://www.heritagecouncil.ie/fileadmin/user_upload/Publications/Marine/ClimateReportWeb_version_june_09FINAL.pdf

Ireland at Risk – Critical Infrastructure – Adaptation for Climate Change
http://www.iae.ie/site_media/pressroom/documents/2009/Nov/17/Ireland_at_Risk_2.pdf

Adapting to Climate Change – An Introduction for Public Sector policy makers resource managers and practitioners. (Scottish Climate Change Impacts Partnership)
http://www.adaptationscotland.org.uk/3/107/0/Adapting-to-Climate-Change--An-introduction-for-the-public-sector.aspx

Managing Adaptation: Linking Theory and Practice (UKCIP)
http://www.ukcip.org.uk/wordpress/wp-content/PDFs/UKCIP_Managing_adaptation.pdf

Urban Adaptation to Climate Change in Europe (European Environment Agency)
http://www.eea.europa.eu/publications/urban-adaptation-to-climate-change

London Climate Change Partnership: Adapting to Climate Change the Role of Public Procurement
www.london.gov.uk/.../publications/adapt-climate-change-sept09

A list of publications by ICARUS can be found at http://icarus.nuim.ie/publications

A list of other useful publications can also be found at
http://www.ukcip.org.uk/?s=publications

USEFUL WEBSITES

http://climate-adapt.eea.europa.eu/
(This website acts as a portal to numerous other web tools on adaptation)

www.epa.ie

www.opw.ie/en/FloodRiskManagement/

www.flooding.ie/en/Intheeventofaflood/

www.met.ie

www.icarus.nuim.ie

www.coford.ie

http://www.c4i.ie/

www.marine.ie

icarus.nuim.ie/coco-adapt

www.cmrc.ie/coastal-governance.html

www.cmrc.ie

http://www.ukcip.org.uk/news/#1

www.eea.europa.eu

http://eucities-adapt.eu/cms/

www.imcore.eu

http://www.circle-era.eu/np4/WS_UNCERT.html

http://www.defra.gov.uk/environment/climate/government/departmental-adaptation-plans/

http://www.wri.org/

http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml

http://www.oecd.org/document/58/0,3746,en_2649_34361_36738106_1_1_1_1,00.html

ANNEX IV

OVERVIEW OF CHALLENGES FOR SECTORS

1. WATER, COASTS AND MARINE

Context

Water resources and water supply systems are directly impacted by climate change. The management of these resources affects the vulnerability of ecosystems, socio-economic activities and human health. Strategies for managing water need to be adapted to take account of new climate change realities.

The *Water Services Investment Programme 2010 -2012*[37] states that the planning of future schemes will need to take account of best practice in relation to energy efficiency and account must be taken of the development of national policy on adaptation to the inevitable impacts of climate changes. The *Programme for Government*[38] provides for the establishment of a new State-owned national water authority to take over responsibility for managing and supervising investment in water services infrastructure and to manage the domestic water metering programme.

The *Water Framework Directive* (WFD)[39] came into force in December 2000 and establishes a new legal framework for the protection, improvement and sustainable use of all water in Europe. The Directive's river basin planning process involves an integrated planning approach with regard to land, water and ecosystem management, involving economic considerations and requiring a high level of public participation. The Directive also requires coordination with the relevant authorities in Northern Ireland. Fully integrating climate risk considerations with the Water Framework Directive planning process is key to the adaptation strategy. This will need to be supported by further research to ensure that proper decisions on adaptation can be taken. The *Water Framework Directive* is complemented by the *Floods Directive* which establishes a framework for the assessment and management of flood risks.

The Office of Public Works undertook a *Strategic Review of Options for Flood Forecasting and Flood Warning in Ireland in 2010/2011* and is currently consulting

37 http://www.environ.ie/en/Environment/Water/PublicationsDocuments/FileDownLoad,22735,en.pdf

38 http://www.taoiseach.gov.ie

39 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:NOT

with stakeholders on options to implement the recommendations of the report in order to minimize the impacts and damages caused by flooding.

A Summary of the State of Knowledge on Climate Change Impacts for Ireland (Desmond et al., 2009), indicated that fresh-water resources are vulnerable and have the potential to be strongly impacted by climate change. Adapting to these challenges created or aggravated by climate change will require an integrated approach to both water resources and flood management.

Issues such as abstraction controls must take account of future changes in rainfall patterns and consequent impacts on availability of water resources. Design standards for critical infrastructure, may need to be adapted to cope with more frequent flooding.

Businesses relying heavily on water must consider water efficiency measures as part of their future business models, including alternatives to treated water. Successful adaptation to the impacts of climate change on water will depend not just on effective national and European water regulations, but also on the extent to which water management can be integrated into other sectoral policies such as agriculture and energy policies.

The oceans and seas around Ireland and its coastline will be affected by climate change. Sea-level rise and increased storm intensity and surge, will affect wetlands, rivers, lakes and estuaries as well agricultural land, coastal communities, the fishing industry and our ports. Adaptive planning to minimise the negative impacts is required. The *Marine Strategy Framework Directive*[40] facilitates adaptation by ensuring that climate change considerations are incorporated into marine strategies and by providing a mechanism for regular updating to take account of new information.

Summary of Impacts

Water Resources

- Increased risk of flooding in river systems which could lead to a risk of contamination and pollution of water supplies.
- Drier summers could make water resources vulnerable, especially in the East and South East.
- Water shortages in the summer leading to greater pressure on groundwater sources.
- Increased pressure on sewer networks and water purification during extremes.
- Increased microbial activity increase.

[40] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0056:EN:NOT

Marine

- Stress to aquaculture/fish stocks due to extreme water temperature.
- Local flooding in estuarine regions.
- Change in sea level to worsen impacts of changing storm and wave patterns in coast areas.
- Coastal wetlands, flood plains and estuaries at risk from salt water.
- Coastal erosion and danger to coastal settlements and infrastructure.

2. AGRICULTURE, FORESTRY AND BIODIVERSITY

Context

Given its importance on food production and economic grounds, the Irish agriculture sector must be in a position to anticipate and adapt to the negative impacts of climate change, as well as looking to maximise the benefits for the food production system. This is especially important in view of the launch in 2010 of the *Food Harvest 2020*[41] (FH 2020) strategy, which maps out the future development direction of the sector. The compelling vision of Food Harvest 2020 is of efficient, environmentally sustainable production that delivers significant growth. It is also recognised that climate change will be one of the main drivers that will shape European agriculture and the Common Agricultural Policy (CAP).

Agriculture is a complex and highly managed biological sector, which is still directly dependent on climate, heat, sunlight and water are the main drivers of crop growth. Increased temperatures and changing patterns of precipitation may have significant impacts on the agricultural sector in Ireland.

With the predicted onset of higher ambient temperatures and varying rainfall patterns, agricultural practices and land use in Ireland will need to be modified. In the South and East, for example, where increased summer drought is predicted, the viability of grasslands for livestock and potato growing may be in question due to reduced summer rainfall. The change of land use to cereal production in this area will need to be considered as cereals experience less water stress than grass or potatoes in the summer months. In other parts of the country, the increased ambient winter temperatures may allow for cereal production where it is currently not possible due to frost.

The agriculture sector must consider how it will adapt to increased pressure on water availability, the increased risk of changing pest and diseases, and the increased incidence of extreme weather events like flooding and drought.

[41] http://www.agriculture.gov.ie/agri-foodindustry/foodharvest2020/

Climate change will also present both risks and opportunities for the forestry sector. Risks include tree mortality, fire, extreme weather events, and pest and disease outbreaks. Opportunities include potential increases in productivity and the range of species that can be grown. The impacts of climate change on forest growth and species distribution has been addressed in the CLIMADAPT project, funded under the COFORD programme of the Department of Agriculture, Food and the Marine. The CLIMADAPT project has developed a web-based species selection tool which is available at http://www.coford.ie/toolsservices/climatechangeandforests/ to assist managers in selecting and forecasting species suitability to specific site types under future climate change scenarios. However, more research is required on the impacts of climate change on forest growth and species distribution.

Fully functioning ecosystems and they services they provide are essential to many sectors of the Irish economy and society. Such services may be under threat from climate change. Biodiversity in Ireland is already being impacted by climate change with changes in timing of flowering and bird migration. It is acknowledged that some of our habitats could be adversely impacted by extremes in weather leading, for example, to negative impacts for the agriculture and tourism sectors. ICARUS produced a briefing paper in 2009, entitled *Biodiversity and Climate Change in Ireland* which sets out the impacts of climate change on Ireland's ecosystems and makes recommendations on actions to protect and conserve our biodiversity from the impacts of climate change.

Summary of Impacts

Agriculture

- Warmer temperatures will increase the risk of pest survival and could attract new pests.
- Improved conditions for plant growth may increase yields; however, risks to water availability may offset any gain.
- Potential benefits for animal husbandry related to shorter housing periods.
- Increased drainage and irrigation requirements.
- Fewer cold snaps will result in less frost damage to spring crops.

Forestry

- Increased productivity but also increased threat of pests and pathogens.
- Timber quality impacted due to rapid growth.

Biodiversity

- Phenological studies across Europe suggest both animals and plants respond to temperature changes in a variety of ways; this will have implications for ecosystems.
- Many ecological systems may suffer increased stresses due to heat waves and extreme events.
- Potential arrival of exotic and alien species.
- Destruction of fragile ecosystems; in particular coastal ecosystems could be more vulnerable.
- Increased pathogens and pests.
- Disruption of food web and stress on breeding cycles.
- Species decline or extinction.

3. ENERGY, TRANSPORT, COMMUNICATIONS AND INSURANCE

Context

Infrastructure systems in the energy, transport, communications and industry sectors have an essential role in ensuring socio/economic wellbeing. Major and on-going investments are made in these areas. Climate change has the potential to have a significant negative impact on these sectors. It is clear is that there are some significant long-term risks for infrastructure both from extreme weather events (such as flooding) and gradual climate change. Major disruption to infrastructure associated with high winds and flooding are already a reality, with significant economic and social consequences.

Ireland has witnessed a great many economic changes over the past two decades, including substantive investment in road and rail infrastructure as well as the widespread availability of broadband. In parallel, the energy sector has expanded to meet rising energy demands. *The National Energy Efficiency Action Plan*[42] is designed to chart Ireland's path towards a more sustainable future. Our energy policy is informed by the EU's ambitious energy policy. This includes the *Climate and Energy Package (2008)*[43] which outlines a wide range of actions on alternative low-carbon sources of energy and using energy more efficiently.

Possible climate change impacts on the energy sector will potentially have consequences for both energy resources and the sustainability of the supply infrastructure. These could include a change in demand for heating, increased negative impact on the water cooling of power stations, potential for greater damage

[42] http://www.dcenr.gov.ie/NR/rdonlyres/FC3D76AF-7FF1-483F-81CD-52DCB0C73097/0/NEEAP_full_launch_report.pdf

[43] http://ec.europa.eu/clima/policies/package/index_en.htm

to wave and tidal systems in extreme events, potential flooding of facilities, damage to power lines and disruption to power stations.

Like the energy sector, developments in the transport sector are informed by European policy that aims to reconcile the growing needs of citizens with the requirements of sustainable development. In March 2011, the European Commission presented its White Paper *Roadmap to a Single European Transport Area*[44] a series of 40 concrete initiatives for the next decade to build a competitive transport system. This will influence the evolution of Ireland's transport policy. Specific climate change impacts to the transport sector in Ireland include challenges to local ports, roads, railways in the event of an increase in sea levels and coastal erosion, the possible effects on rail and road infrastructure of higher peak temperatures, storm damage, and disruption to the road and rail network caused by severe cold weather and flooding.

The communication sector provides a critical operational service for other sectors including the business and domestic sectors. Any negative impact on the communication sector may have damaging repercussions for other sectors. In response to-risks and opportunities in the communications sector, a range of adaptive practices to identify, respond to, and stay ahead of current and expected disruptions must be considered and acted on.

It is also important for Ireland's economic development that businesses and enterprise of all sizes and in all sectors understand the risks and opportunities that may arise. By exploiting the opportunities and reducing the impacts posed by climate risks, successful adaptation can ultimately boost economic growth. Incorporating the idea of climate risk or opportunity as an additional consideration in business planning is an important low-cost first step for businesses. A recent Forfás report, *'Adaptation to Climate Change; Issues for Business*', sets out actions for adaptation for this sector.

Disaster risk reduction is very relevant to all sectors including the financial and insurance sector, as effective emergency management may help to prevent significant losses and financial disasters. The *Framework for Major Emergency Management*[45]is a Framework enabling An Garda Síochána, the Health Service Executive and local authorities to prepare for and make a co-ordinated response to major emergencies resulting from events such as fires, transport accidents, and severe weather. Nationally, there are opportunities to improve the provision of information on climate impacts to inform preparedness, planning, response and recovery activities for emergency management. Early warning systems are essential to mitigate disasters. Accordingly, early warning systems need to be devised and put in place that will integrate extreme events (e.g. flooding, cold snaps, heat waves) into existing emergency planning and response mechanisms.

[44] http://ec.europa.eu/transport/themes/strategies/2011_white_paper_en.htm

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http://www.environ.ie/en/Publications/LocalGovernment/FireandEmergencyServices/FileDownLoad,810,en.pdf

Insurance mechanisms can contribute to adapting to climate change by covering the residual risks and providing incentives for risk reduction. The main role of insurance in adaptation to climate change would be to:

(i) reflect costs of climate change risks;
(ii) provide incentives for adaptation; and
(iii) cover remaining risks that cannot be prevented.

In providing incentives for adaptation, it is very important that the insurance industry inform insurance takers of available adaptation (risk reduction) options and adequately adjust the premium price when such measures are implemented.

The insurance sector must play a key role alongside other stakeholders in securing an effective system of flood management and protection. The insurance sector, as with all other sectors, has a role to play in capacity-building by raising awareness among stakeholders of the impacts of climate change and how best to prepare and deal with its effects.

Summary of Impacts

Energy

- Possible increase in summer electricity demand for air conditioning.
- Increased solar power generation potential coinciding with lower wind generation potential.
- Water cooling of power stations will be impacted.
- Potential for greater damage to wave and tidal systems in extreme events.

Transport

- There is significant potential for impacts on transport infrastructure, especially from storms and flooding.
- Dangerous road conditions.
- Infrastructure in coastal areas could be severely threatened e.g. rail network could be vulnerable.

Communications

- Increase risk of storm and flood damage to telecommunications system.

Business and Industry

- Industries with high water demand will be impacted.
- Increased risk of storm and flood damage to larger industrial infrastructure and mobile machinery.

- Reduction in productivity as a result of employees' inability to get to work, as a result of extreme events.
- Insurance availability and cost.

4. HERITAGE

Context

Fáilte Ireland together with the Heritage Council has jointly published a report investigating how climate change might impact the heritage of our coastline and inland waterways, and the overall Irish tourism industry which relies heavily on these assets.

The report, entitled *Climate Change, Heritage and Tourism: Implications for Ireland's Coast and Inland Waterways* (Heritage Council, 2009), looks at the possible climate scenarios Ireland is likely to face as a result of climate change, and how these potential changes are likely to affect both the tourism industry and Ireland's natural heritage. The report outlines a number of definable actions which can be taken now in order to adapt to the impacts of climate change. This provides a first step in the adaptation process to climate change in these sectors.

5. HEALTH

Context

The EU Health Strategy for 2008-2013 - *Together for Health: A Strategic Approach for the EU 2008-13*[46] identifies the protection of people from health threats due to climate change as a priority.

Climate change affects human health in a number of ways. Direct impacts come from temperature-related illnesses and deaths or extreme weather events. Meanwhile, climate changes will affect the spread of water-, food- or vector-borne borne diseases, and have other impacts on food or water supplies. The quality of our air, both outside and indoors, also impacts directly on our health

Summary of Impacts

Human Health

- Decline in winter deaths as a result of milder winters.

[46] http://ec.europa.eu/health-eu/doc/whitepaper_en.pdf

- Changing infectious disease patterns due to changes in ecosystems.
- Increased water temperatures leading to possible water pollution illness.
- An increase in skin cancers and heat wave related morbidity and mortality.
- Increase in food borne diseases.
- Increase in psychological problems relating to extreme weather events
- Potential population displacement with associated health risks.

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