

Local Authority Adaptation Strategy Development Guideline

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ENVIRONMENTAL PROTECTION AGENCY

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

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

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Local Authority Adaptation Strategy Development Guideline

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Prepared for the Environmental Protection Agency

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Executive Summary

Climate change is no longer a theoretical threat to be dealt with by future generations – its impacts are with us today. Since 1900, the temperature of the atmosphere has risen globally by close to 1°C at the surface, in turn increasing the atmosphere's capacity to hold water by about 7% and leading to a rise in sea level of 20 cm, through a combination of thermal expansion and run-off from ice melt. To date, climate change has played a role in the occurrence of heatwaves across Europe, more moisture in the atmosphere has contributed to intense downpours and unprecedented flooding, and rising sea levels have contributed to waves breaking over the streets and homes of coastal dwellers during Atlantic storms.

Although at times challenging, these impacts have not yet caused the key services that society relies upon to fail irrevocably. In the wake of extreme events authorities and agencies have to date largely been able to simply clean up, rebuild and return the affected area to some semblance of normality. But this will become increasingly difficult in future. The risk is that the costs of simply reacting to the impacts of climate change will spiral as extreme events become more severe, and the period of time between events will also shorten, diminishing the economic, physical and psychological capacity of affected communities to recover between shocks.

Climate change mitigation – efforts to prevent the concentration of greenhouse gases in the atmosphere from reaching a dangerous tipping point – is therefore an urgent priority. The Paris Agreement of December 2015 agreed in principle a number of actions intended to bring global greenhouse gas emissions to a peak as soon as possible, with the hope that emissions may be balanced by removals during the second half of this century. Accordingly, if urgent action is taken to enact the Paris Agreement, the risk of climate change overwhelming the capacity of most societies and ecosystems to adapt to its impacts could be greatly diminished.

However, when it comes to climate change adaptation, the urgency to respond is somewhat different. While mitigation demands immediate action, adaptation requires immediate planning. Fortunately, there is sufficient time to plan in a considered and coherent way how to adapt

our towns and cities, and the support systems they rely on, to the future impacts that climate change will bring. To do so will require the development of long-term, wide-ranging strategies, setting out high-level visions of how we might effect a transition towards the level of climate resilience that society will require in future.

In Ireland, how strategies of this kind will be developed, and by whom, is set out under the National Climate Change Adaptation Framework (NCCAF). The NCCAF mandates local authorities and key sectors with the task of planning for the impacts of climate change in Ireland. In line with the European Union Adaptation Strategy (COM(2013) 216 final), the NCCAF outlines the need for local authorities to take a long-term view of climate change adaptation:

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.

DECLG, 2012, p. 39

The purpose of this guideline is to support local authorities in the development of a local climate change adaptation strategy. In its structure and content, the guideline draws heavily on the 2013 *Guidelines on Developing Adaptation Strategies* provided to European Union Member States by the European Commission (SWD(2013) 134 final), with the aim of fostering coherence between strategies developed at local and national scale.

The guideline is broken down into seven chapters, with Chapters 2–7 dealing with distinct phases of the process of developing an adaptation strategy.

Chapter 1 provides background information on what adaptation entails and provides the rationale behind implementing an adaptation strategy.

Chapter 2 outlines the initial steps required in launching a strategy development process, describing key roles and who can fulfil them, and setting out important factors to consider in the early stages of strategy development.

Chapter 3 explains how to assess the role that weather extremes and climatic trends currently play within the local jurisdiction, and it describes why doing so is a fundamental element of working towards a more climate-resilient future.

Chapter 4 moves from the present to the identification of future climate risks, describing a staged risk assessment process and positioning the adaptation strategy

within more detailed risk assessments undertaken during shorter term decision-making processes such as statutory plan-making.

Chapter 5 describes the types of adaptation options that are available to address the risks identified in the previous chapter, and outlines how each might be assessed and prioritised for implementation.

Chapter 6 introduces the pathway planning approach and illustrates how it can be useful in scheduling key decision points during the lifetime of the strategy.

Chapter 7 outlines the steps required to move from a phase of planning to one of implementation, and it explains the importance of monitoring and evaluation in ensuring that the strategy is achieving its anticipated adaptation outcomes.

1. Background

Ireland's climate is changing, and will continue to change for many decades to come. The combustion of fossil fuels since the Industrial Revolution has led to a concentration of carbon dioxide (CO₂) in the atmosphere that now exceeds 400 parts per million.

Sophisticated computer modelling of the projected impacts of increased concentrations of greenhouse gases (GHGs) in the atmosphere has been undertaken, and this has been calibrated against the observed changes in climate over the last century. These models suggest that increases in energy-trapping gases in the atmosphere will result in an upwards trend in temperature, coupled with a significantly more extreme climate than that to which human civilisation has grown accustomed (IPCC, 2014). In Ireland, winters will become wetter and summers drier (Gleeson *et al.*, 2013; McGrath and Lynch, 2008). Milder winter temperatures may be of benefit to certain sections of the community, but this will be offset by the potential for heatwaves during summer. Rising sea levels will also increase the risk of coastal inundation. We now know that a period of unprecedented change is upon us, so what should we do?

1.1. Climate Mitigation versus Adaptation

Climate policy has been, and must continue to be, focused on the issue of *mitigation*, that is, efforts to restrict new emissions of GHGs and enhance carbon sinks. Carbon sinks such as plants, soils and oceans act to remove carbon from the atmosphere. Climate change mitigation is a critical priority if a catastrophic rise in global mean surface temperature in the region of 4°C is to be avoided. However, with change now a certainty over the coming century, climate change *adaptation* is also becoming an urgent policy priority. Adaptation involves taking steps to adjust human and natural systems in response to existing or anticipated climatic change, in order both to avoid unwanted impacts and to take advantage of new opportunities that may arise. Ideally, adaptation should take place in a pro-active and anticipatory manner, thereby preventing the worst of the risks to society that accompany climate change.

Scientific research into the impacts of climate change for Ireland has been under way for some time, and a broad understanding of the probable temporal and spatial distribution of changes in temperature, precipitation, sea levels and flood risk is now beginning to coalesce. These insights are sufficient to allow us to begin the process of adaptation planning in earnest.

1.2. Adaptation Policy: EU and Ireland

The European Commission (EC) published the European Union (EU) Adaptation Strategy in April 2013 (COM (2013) 216 final), which sets out eight key actions to progress adaptation among Member States (Box 1.1). For Ireland, the Adaptation Strategy, and the White Paper that preceded it, frame adaptation policy, providing a high-level framework for the development and use of adaptation support mechanisms.

Box 1.1. Actions described by the EU Adaptation Strategy

Action 1: Encourage all Member States to adopt comprehensive adaptation strategies

Action 2: Provide LIFE funding to support capacity building and step up adaptation action in Europe (2013–2020)

Action 3: Introduce adaptation in the Covenant of Mayors framework (2013/2014)

Action 4: Bridge the knowledge gap

Action 5: Further develop Climate-ADAPT as the “one-stop shop” for adaptation information in Europe

Action 6: Facilitate the climateproofing of the CAP, the Cohesion Policy and the CFP

Action 7: Ensure more resilient infrastructures

Action 8: Promote insurance and other financial products for resilient investment and business decisions

CAP, Common Agricultural Policy; CFP, Common Fisheries Policy.

In response to the White Paper, the Department of Environment, Community and Local Government published a National Climate Change Adaptation Framework (NCCAF) in December 2012. Under the NCCAF, adaptation duties are distributed between government departments and state agencies on a sectoral basis, and local authorities on a spatial basis. In particular, the NCCAF mandates local authorities with the task of reviewing spatial plans for their adaptation fitness.

This task places a number of key responsibilities for the planning and implementation of adaptation in Ireland with local authorities. Devolution of decision-making to the local level in this way is appropriate – the impacts of climate change and the need and capacity to respond to them are very different in different areas of Ireland. Rainfall shortages in one region may not affect another, for example, and local knowledge of how to rapidly implement temporary flood defences in one area may be lacking in another that has no living memory of flooding. There is no uniform impact regime or adaptation response that can be managed centrally, and local understanding of and sensitivity to change is crucial to getting adaptation right.

1.3. Guideline Purpose and Structure

After a two-year period of local authority consultation, development workshops and a pilot programme, the most appropriate means by which to advance adaptation at the local scale has become clear. In Ireland, the development of a local authority-level climate change adaptation strategy will allow a sufficiently long-term view to be taken of the challenges posed by climate change. Existing statutory planning processes are unable to account for the long-term nature and broad scale of climate adaptation challenges.

A separate and distinct adaptation strategy at local authority level is therefore required. To that end, this guidance document was commissioned by the Environmental Protection Agency (EPA) to help local authorities to develop their own adaptation strategy. The strategy, once approved, should be used by a local authority to assess the adaptation fitness of its spatial plans and the other plans and policies under its remit. This will fulfil and build on the mandate provided to local authorities under the NCCAF.

By drawing on the established successes and distilling the lessons learned by early movers on adaptation, including those in Canada, Denmark, the Netherlands and the United Kingdom, the approach outlined here will guide local authorities through the key phases of an adaptation strategy-building process (Box 1.2).

1.3.1. How to use this guide

The structure of this guide is set out in Box 1.2. There are six sections, each of which contains a number of steps for completion, culminating in the development and implementation of an adaptation strategy. Although the sections are laid out sequentially, it should be noted that there are a number of points in any adaptation process where moving backwards or forwards to revisit a step or anticipate a future one may be appropriate.

1.4. Why Adapt to Climate Change?

- The concentration of long-lived GHGs in the atmosphere has been steadily increasing since the Industrial Revolution. Although the rate of increase was initially slow, the rapid acceleration in emissions over the past 30–40 years has meant that a substantial warming of the climate is now unavoidable, regardless of efforts to curb future emissions. Adaptation to the impacts of climate change is therefore essential (Figure 1.1).
- Climate change poses a number of significant hazards to society and the environment. Unless early action is taken to identify, understand and begin to deal with them, it may be too late to choose the way in which to adapt to climate change.
- Climate change may also bring opportunities for cost savings, may allow new businesses to emerge or may make possible new ways to foster environmental sustainability. Those who have adapted to change in the most far-sighted and cost-effective manner will enjoy a competitive advantage over those who have failed to act.
- We are unlikely ever to be totally insulated from the effects of the climate we live in, and nor would we necessarily want to be. But we do need to take steps now to ensure that we are as resilient as possible to potential future climate changes and, in so doing, to make ourselves better able to cope with climate change in the present.

Box 1.2. The six-step structure of this guideline

Step 1: Forming an adaptation team and preparing the ground

- Convene a core adaptation team.
- Develop a stakeholder engagement and communication plan.
- Plan collaboration with other local authorities and key sectors.

Step 2: Assessing the current adaptation baseline

- Identify the impacts of current weather extremes and recent climatic trends.
- Estimate costs of current weather extremes and climatic trends.
- Map roles, responsibilities and affected stakeholders in relation to identified impacts.
- Identify existing policies and measures linked to the management of identified impacts.
- Assess lifetime and efficacy (including threshold values) of current policies and measures.

Step 3: Assessing future climate risk

- Identify future climate risks.
- Set objectives in relation to managing future climate risks.

Step 4: Identifying, assessing and prioritising adaptation options

- Identify adaptation options.
- Assess each option across a number of criteria.
- Prioritise options for implementation.

Step 5: Developing an adaptation pathway map and drafting the adaptation strategy

- Develop an adaptation pathways map.
- Select a desired adaptation pathway.
- Draft a strategy for the implementation of desired adaptation options.
- Allocate roles and responsibilities for implementation.

Step 6: Mainstreaming, monitoring and reviewing the adaptation strategy

- Implement the strategy via policy and planning instruments.
- Determine monitoring requirements and decision thresholds.
- Schedule strategy review and reiteration.

Climate change: potential impacts for Ireland?



Storm surges and waves

Storm surge events will increase in frequency, with the height of extreme surges also increasing significantly on the western coasts during winter. Wave heights may also significantly increase, with extreme waves increasing by around 10% on the north-west coast.

Weather extremes

While the frequency of very intense cyclones affecting Ireland is likely to increase, it is difficult to say with any certainty how extreme weather events will be impacted by climate change. Nevertheless, additional energy trapped in the atmosphere by greenhouse gases is likely continue to stimulate greater atmospheric volatility.



Fluvial flooding

There may be an amplification of the seasonal cycle in Ireland, increasing run-off to catchments in winter and decreasing flows in summer. There is likely to be a clear pattern of increased flows to river catchments in the winter and autumn and a decrease in flows during the summer, though the scale of change is difficult to accurately gauge. There will nevertheless be significant consequences for the management of flood defences, water supplies, waste treatment and biodiversity conservation.

Sea level rise

Satellite altimetry has identified a rise of around 3.5cm per decade in the seas around Ireland, in line with the IPCC's global projections. However, any acceleration in the melting of polar ice sheets could see a substantial increase in sea levels.



Precipitation

Autumn and winter will become significantly wetter by the end of the century, with summers likely to become substantially drier over the same period. Some models project increased rainfall in winter/autumn of up to 25% and a decline of up to 18% in summer. However, the accuracy of these projections has been difficult to verify, leaving the precise figures of the pattern of wetter winters and drier summer difficult to unambiguously report.

Sea temperatures

Temperatures in the sea around Ireland have risen in recent decades, observations since the 1980s showing a warming trend of 0.3–0.4°C per decade in Irish waters, with the Irish Sea warming at an even faster rate. These changes will have a profound effect on the marine ecosystem, including the distribution and abundance of commercially significant species such as mackerel.

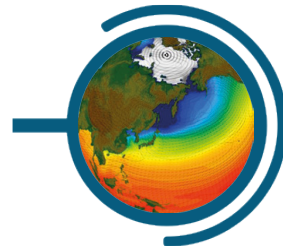


Figure 1.1. Potential climate change impacts for Ireland.

2. Forming an Adaptation Team and Preparing the Ground

Overview
One of the most crucial elements in developing an adaptation strategy is ensuring the involvement of the right people at key stages of the process. At local authority level, the nature of the tasks that are required to adapt to climate change dictate that “the right people” will be drawn from a wide range of disciplines, will include different actors at different times and, in order to secure access to sufficient resources to ensure that the strategy is implemented, must include senior management figures.
Key tasks of Chapter 2
<ul style="list-style-type: none"> • Convene the adaptation team. • Appoint an adaptation team leader. • Develop a clear regional and sectoral collaboration plan. • Develop a clear stakeholder engagement and communication plan.

2.1. Convene an Adaptation Team

Adaptation is a cross-cutting issue that requires an integrated and explicitly collaborative approach. The types of measures that must be implemented to adapt to climate-related issues (such as flood management) involve multiple fields of expertise. Accordingly, it is essential to use a broad spectrum of knowledge when formulating adaptive responses to climate change (EC, 2013). It is therefore crucial for local authorities, when developing an adaptation team, to take appropriate steps to ensure that all relevant sectors of a local authority are represented on the adaptation team and that such representation is at an appropriately senior level.

2.1.1. Leadership

There is growing evidence that the inclusion of a highly motivated, dedicated and knowledgeable individual to serve as a catalyst to others involved in an adaptation process is extremely beneficial. If such a “climate champion” is available, then the local authority should consider involving them on the adaptation team, whether in a lead role or as another important member of the team. This is more likely to be beneficial to the overall strategy preparation process than a prescriptive approach to selecting a team leader based upon a particular function alone.

2.1.2. Team members

When convening the adaptation team, a leader should attempt to draw on all relevant departments, skillsets and disciplines across the authority (Table 2.1). This core team will conduct the majority of the tasks required in developing a strategy and will also be required to interact with stakeholders in the local area and other local authority administrations.

Table 2.1. A (non-exhaustive) list of the disciplines, knowledge domains and departments from which to seek representation when convening the core adaptation team

Internal departments, knowledge domains and disciplines to consider for inclusion in the core adaptation team	Biodiversity
	Building control
	Coastal management/recreation
	Environment
	Economic development
	Finance
	Heritage
	Housing
	Information systems/GIS
	Planning/planning policy
	Roads/transport
	Water services
	Waste
	Educational and community services
	Emergency response organisations

2.2. Develop a Stakeholder Engagement and Communication Plan

Stakeholder participation is stipulated under the NCCAF, principally in order to:

- promote the integration of a range of knowledge and values in adaptation;
- build a constituency of support behind the adaptation process via embedding it in local interests and concerns;
- ensure that adaptation processes at the local scale are aligned with similar processes that are under way in neighbouring authorities and relevant sectors.

The adaptation strategy development process must therefore include a structured and substantive programme for the engagement of stakeholders from within the local community, relevant non-governmental organisations and state sector bodies.

2.2.1. Plan community engagement points

There are likely to be a number of key stages of the adaptation strategy development process at which input from the local community will be of particular relevance and value. For example, stakeholder knowledge and opinions regarding the impacts of current weather events and trends, sensitivity to climatic factors, or prioritisation of adaptation options may be beneficial to elicit via workshops or surveys.

Key issues to consider when planning community engagement include the following:

- Clarifying what must be achieved from the engagement process, taking a strategic and cost-effective approach regarding who is engaged and how. In the interests of efficiency, adaptation may fit on the agenda under a number of other meeting or communication contexts.
- Framing climate change in order to clarify the impacts of relevance to participants. Stakeholders will more readily identify with locally focused problem contexts than the generalities of climate change.
- Using local contacts and networks to provide entry points for the recruitment of wider groups, where wider involvement is practical and desirable. In

many cases, carefully targeting smaller groups of those who are most willing and most influential for more thoroughgoing interaction may be more effective (see Figure 2.1).

- Being forthcoming and transparent with respect to the degree of influence that contributors will have at specific stages of the process and its overall outcome (Gardner et al., 2009).

2.2.2. Plan effective communication

The best strategy for effective stakeholder communication is active participation in the process, but where this is impossible or impracticable owing to resource and/or time constraints, a minimum requirement is the timely and effective communication of the instigation of an adaptation process and regular updates on progress made. This will allow interested parties to make further enquiries and to engage in a more substantial manner as appropriate.

In order to communicate effectively, identifying the target stakeholder audience is essential (Holstein, 2010). Using established mechanisms such as the internet, social media, newsletters and the local press is a simple and cost-effective means of communicating with the wider community. However, it is important to bear in mind the nature of discourse on climate change, particularly the many widely held misconceptions surrounding it, and on-going efforts to undermine its scientific credibility on political grounds.

Box 2.1. Public engagement: key climate challenges

- Climate science is poorly understood.
- Climate change is incorrectly assumed to be a problem:
 - of the far distant future;
 - of global rather than local concern;
 - of interest only to the “green” lobby.
- Significant scepticism surrounds climate change; some may even seek to categorise it as a belief system or political conspiracy rather than a field of science.
- Long-term planning is required to coherently approach climate adaptation, which runs counter to contemporary social and political practices (Holstein, 2010).



Figure 2.1. Stakeholders can be a hugely beneficial resource to use in fostering adaptation, provided that they are convinced of the merits of proposed adaptation measures and feel that there is a viable structure to the process with which they are engaging (image: Stefan Gray).

Overcoming the many challenges involved in engaging the public with the adaptation process (see Box 2.1) can be time-consuming. Providing information that will fill the gaps in the public understanding of the science of climate change, clarifying that the uncertainty in climate projections is often no greater than that surrounding projections of economic or social change over the long term, and contextualising climate impacts as practical and immediate planning issues rather than ephemeral environmental concerns, will take considerable effort. However, when it comes to implementing any adaptation measures, public support is crucial to their success. The benefits of early and substantial public engagement therefore far outweigh its costs (Gardner et al., 2009; Holstein, 2010).

The requirement for and benefits of engaging with specialist stakeholders from linked local authorities and key sectors will be discussed in the following section.

2.3. Plan Collaboration with Other Local Authorities and Key Sectors

Collaboration across authority boundaries (i.e. with those sharing a river basin, catchment, coastal cell or critical resource) is advisable at various stages throughout the adaptation strategy development process (Gardner et al., 2009).

There are numerous drivers for inter-authority collaboration on climate adaptation, including:

- ensuring that adaptation actions taken in one authority do not result in negative consequences for another;
- capitalising on economies of scale where an adaptation measure might appropriately span multiple authorities;
- widening the pool of knowledge and experience upon which the core adaptation team may draw in drafting its strategy.

2.3.1. *Adopting a regional approach*

Local authorities in Ireland have well-established regional collaborative fora, focusing on such topics as Strategic Environmental Assessment (SEA) or renewable energy. Adopting a regional partnership approach to the development of adaptation strategies is therefore appropriate.

When deciding on regional collaborative partners, the geographical interdependencies of the authority should be assessed. Are there natural resources, catchments, coastal cells or habitats that span multiple jurisdictions beyond your own? On the basis of these physical interdependencies, sketch an appropriate geographical boundary for collaboration, noting the authority jurisdictions it spans. These are the authorities that will need to be involved at various points in the development of your adaptation strategy. River Basin Districts may be an appropriate reference point when determining with which authorities to collaborate when developing an adaptation strategy.

2.3.2. *Involving sectors*

The involvement of sectoral representatives (as identified under the NCCAF) such as the Office of Public Works (OPW) or the Department of the Environment, Community and Local Government can be decided along similar lines. For the purposes of the NCCAF, 16 key “sectors” have been identified, which must prepare adaptation plans of their own. These adaptation processes will carry a number of critical implications for adaptation planning at local authority level (and vice versa), and collaboration should therefore be fostered

wherever possible. At the time of writing, no specific body or institution has yet been tasked with the coordination of sectoral and local-scale adaptation efforts. In the interim, voluntary collaborative arrangements can and should be pursued.

Before moving on

It is important to try to ensure that as broad a range of departments as possible are represented on the adaptation team, and that senior management are aware of the strategy development process and will be offered opportunities to contribute to it. Raising the profile of the team's work within the authority will help in securing access to meet with people during the baseline assessment that follows.

Key outputs of Chapter 2 to include in the strategy

- A list of contributing adaptation team members.
- A clear statement of the authorities with which to collaborate in the development of the strategy.
- A clear statement of the sectors with which to collaborate in the development of the strategy.
- A plan of how and at which stages in the development of the strategy external stakeholders will be engaged.

3. Assessing the Current Adaptation Baseline

Overview

Understanding how well adapted an authority is to current weather extremes and climatic trends is a crucial first step in developing an adaptation strategy. This assessment will take in, at a minimum, 30 years prior to the present day.

The purpose of the assessment is to understand more fully which climatic issues are a concern in terms of the costs (economic and otherwise) they carry for the local area. Equally, finding out in explicit detailed terms which climatic issues *are not* a concern is vital given the limited resources available to enhance climate resilience. These details, in conjunction with a scan of the plans and policies currently on the horizon, will provide a map of the terrain that an adaptation strategy must traverse.

Key tasks of Chapter 3

- Gain a clear understanding within the adaptation team of the impacts of weather events and climatic trends on the local area.
- Prepare a coherent map of who is responsible for the planning and management of climate adaptation-related fields.
- Ensure that the policies, regulations and plans that will shape action in response to climatic impacts in the short to medium term are clearly detailed.

3.1. A Baseline Assessment: What Is Likely to Emerge?

Conducting a baseline assessment may well illustrate that an authority's capacity to cope with existing climatic events and trends falls short of what might be considered optimal, either in terms of what current policies or legislative instruments stipulate, or simply in terms of internal expectations regarding the resilience of key services to climatic events.

Shortfalls or adaptation deficits (Burton, 2004) of this nature typically result from decades or even centuries of developmental pressures rather than recent policy shortcomings. As a result of historical patterns of development, most cities around the world function under a substantial adaptation deficit. The riverine and coastal environments that provided early settlers with ready access to natural resources and trade routes are by their nature dynamic, running counter to the perception of permanence held by those who now inhabit them.

The early phases of an adaptation strategy are therefore typically focused on simply taking steps to address an existing adaptation deficit. Doing so will enhance society's short-term coping capacity, buying valuable time to effect a transition towards greater resilience in the face of a more severe future climate impact regime (Moser and Ekstrom, 2010).

3.2. Identify Current Weather Extremes and Recent Climatic Trends

Taking a 30-year (IPCC, 2014) window as an appropriate sample of current climate conditions, the adaptation team should identify weather extremes and climatic trends that have been of local significance. Events may have included periods of extreme rainfall, flooding, storms, heatwaves or dry spells. Climatic trends may refer to long-term changes in the spatial and/or temporal distribution of precipitation, or changes in average temperature. Table 3.1 provides a number of examples of the type of climatic events and trends that might feature in a baseline analysis.

It should be noted that some of the meteorological and climatic phenomena listed in Table 3.1 (such as "wet days of > 1 mm of rainfall") are insignificant in isolation. These become "extreme events" only when occurring over long periods or in combination with other phenomena and they are listed in order to allow for the categorisation of climate impacts with as great a degree of precision as possible.

A useful starting point in attempting to identify events and trends is the Met Éireann website, which provides

Table 3.1. Examples of the types of extreme events and climatic trends that might feature in an adaptation baseline analysis

Extreme events
Heat wave (>5 days at >25°C)
Absolute drought (> 15 days of <0.2mm of rainfall)
Partial drought (>29 days of average rainfall of <0.2mm)
Dry spell (> 15 days of <1 mm rainfall)
Low-flow events
Cold snap/freezing
Snow events
Wet days (> 1 mm of rainfall)
Heavy precipitation days (> 10 mm of rainfall)
Fluvial flood (1/10 year event)
Fluvial flood (1/100 year event)
Fluvial flood (1/1000 year event)
Pluvial flooding
High winds
Storm surge
Coastal erosion
Climatic trends
Average temperature
Maximum temperature
Minimum temperature
Rainfall distribution
Phenology
Sea level rises
Storminess

a comprehensive list of “Major Weather Events” to have affected Ireland, as well as detailed breakdowns of many of the key phenomena which in combination constituted the event (Met Éireann, 2015). In the interests of brevity, selecting no more than 10 of the most important extreme events of the past 30 years is advisable. Similarly, climatic trends of relevance are likely to number no more than 5–10.

The 30-year timeframe is also useful in terms of being able to interrogate local knowledge of the impacts from those involved in the immediate response and to identify factors that may not have been recorded in the observation data.

3.3. Characterise Climate Impacts Affecting the Authority

Having identified a suitable number of events and trends to analyse, begin to characterise the impacts of

each on the roles and functions of the authority. Were core services disrupted? Were economic costs incurred in order to maintain a requisite level of service to the community? Working across the various departments of the authority, attempt to characterise to what extent each event or trend resulted in service disruption and, where known, any additional costs that were incurred as a result. It is also important to try and assess why these events were disruptive and costly.

Using the criteria described in Table 3.2, a relatively simple, high-level assessment of the disruption caused across the authority can be undertaken.

Table 3.2. Broad categories of service disruption that may assist in determining how to characterise climate impacts across the authority's various policy areas

Impact	Selection criteria
Critical	CORE services or functions within the policy area were COMPLETELY disrupted during the event or in its immediate aftermath
Major	CORE services or functions within the policy area were SUBSTANTIALLY disrupted during the event or in its immediate aftermath
Moderate	CORE services or functions within the policy area were PARTIALLY or INTERMITTENTLY disrupted during the event or in its immediate aftermath
Minor	Core services or functions within the policy area were largely unaffected, but NON-ESSENTIAL or ANCILLARY services or functions were SEVERELY disrupted during the event or in its immediate aftermath
Negligible	Core services or functions within the policy area were largely unaffected, but NON-ESSENTIAL or ANCILLARY services or functions were PARTIALLY or INTERMITTENTLY disrupted during the event or in its immediate aftermath
Beneficial	Services or functions within the policy area IMPROVED during the event or in its immediate aftermath

3.4. Characterise Climate Impacts Affecting the Wider Area and Community

Although a highly detailed analysis of the disruption and costs borne outside the authority is unnecessary for the purposes of developing a long-term strategy, there is nevertheless considerable value in coming to a clear understanding of what other actors, groups and sectors are impacted and the steps that they are likely to be taking in order to adapt. There may be synergies to use

in these adaptive actions, or potential conflicts in the use of shared resources and spaces to avoid.

In addition to conventional desk study, much of the information required to characterise the climatic impact regime of the wider area can be elicited from local sources using simple participatory, qualitative data-gathering approaches such as workshops, meetings and interviews (UKCIP, 2009). Sources of information to use in carrying out this assessment are likely to be well known to the adaptation team and readily accessible, as outlined in Table 3.3.

Table 3.3. Suggested sources of recent weather and climate impact information

Key sources of information to use when characterising the local climate impact regime	Local expert stakeholders
	Local media archives
	National media archives
	OPW
	Insurers
	Emergency service providers
	HSE
	Records and databases held within the authority
	Expertise of the adaptation team

3.5. Map Climate-relevant Policies and Measures

The next key task in preparing an adaptation baseline is to map the policy landscape surrounding the climate impacts identified in the previous step. For instance, where water shortages have proven a problem in the recent past, the Water Framework Directive (EC, 2000) is likely to have had a considerable influence on what has been done recently to manage water supplies, and will continue to have an influence for years to come. In this respect, there are likely to be a number of policies, regulations and legislative instruments originating from the EU, the Oireachtas or the local authority itself that have influenced responses to climate impacts in the past, and which will continue to do so into the foreseeable future.

- List these policies, regulations and legislative instruments, detailing any specific thresholds,

performance values or targets that accompany them.

- Note who is responsible for their planning, implementation and support.
 - Plan-making/co-ordination: the body or agency principally responsible for making decisions regarding impact prevention, response strategy and resource allocation.
 - Implementation: the body or agency principally responsible for the implementation of planned measures and/or ad hoc responses to extreme weather event impacts.
 - Supplementary/support: the body or agency principally responsible for supporting the planning or implementation of responses to impacts (if applicable).
- List any measures and/or plans currently in place to counteract the weather and climatic impacts identified in prior sections. These are likely to include measures as diverse as:
 - early warning systems;
 - engineered defences;
 - planning restrictions;
 - emergency response plans.
- List the estimated lifetime of management measures and plans that are already in place, and note any known design limits or standards applicable to them.

This information is likely to be most easily elicited from the adaptation team via a combination of desk research and workshop interaction (Figure 3.1).

3.6. Summary: Evaluating the Baseline Conditions for Adaptation

Having identified and characterised the climate impacts affecting the authority and the area under its jurisdiction, and having mapped the policy landscape within which management responses to these impacts have been enacted, broad conclusions can be drawn regarding the adaptation baseline. Impacts and their associated costs are likely to have steadily increased in line with global trends.



Figure 3.1. A mixed approach involving short periods of desk research followed by group discussion will allow the various sections of the adaptation baseline analysis to be completed in a timely manner (image: Stefan Gray).

**Box 3.1. Evaluating the adaptation baseline:
some key questions**

- Are there any impacts of climatic events and trends that have caused an unacceptable level of disruption to the authority?
- If so, in what respect?
- Are there impacts that have resulted in policy/ legislative thresholds of performance being exceeded?
- Are there any impacts that might pose an emerging threat to the authority, given:
 - their level of disruption in the recent past, and
 - the margin of safety demanded by current policy and legislation?

The purpose of the questions listed in Box 3.1 is to enable you to begin to prioritise climatic impacts for further analysis during the remainder of the strategy development process.

List the climatic events and trends that have emerged from the baseline assessment, ranking them for the level of disruption they have caused the authority during the preceding 30 years. This will provide a useful lead-in to the risk identification exercise that follows in Chapter 4.

Before moving on

Review the various steps taken to complete the baseline assessment. Ensure that a clear understanding of how climatic events and trends have impacted the authority in the recent past has emerged. Noting costs and making an estimation of the level of disruption caused will be of use in helping to clarify which impacts are of greatest concern. These are the impacts that should be prioritised throughout the remainder of the strategy development process.

Key outputs of Chapter 3 to include in the strategy

- A list of extreme events and climatic trends that have impacted key local authority services and functions (i.e. water supply, drainage, community infrastructure).
- A list of the policies, legislative instruments and regulations pertaining to the management of these impacts, including reference to who is responsible for them and to the plans and actions that have resulted from them.
- A preliminary prioritisation of climatic impacts for subsequent risk assessment.

4. Identifying Future Climate Risk

Overview

Understanding how climate risk is likely to evolve in the future is a crucial element of adaptation strategy development. Chapter 3 dealt principally with what is known about the present and recent past. This chapter will shift the focus towards what is likely to occur in the future, with the aim of identifying those climate risks that are of greatest relevance to the authority.

Key tasks of Chapter 4

- Identification of future climate risks.
- Decisions to be taken regarding those risks that are to be prioritised.
- Outlining the objectives in relation to the management of future climate risks.

Climate change risk assessment (in various different forms) has become commonplace in adaptation planning globally. A number of examples of best practice have thus emerged, which can inform adaptation planning in Ireland:

- from the UK, climate change risk assessments have been undertaken at national and sub-national level;
- from Australia, guidance on how local authorities, public utilities and the corporate sector can best undertake an assessment of climate risk is available;
- from the USA, ICLEI (Local Governments for Sustainability) produced a guidebook for local, regional and state governments within which the assessment of climate risk forms a crucial component.

These examples illustrate the different approaches that can be taken to address risk in planning for climate change. Adopting a staged risk assessment approach (modelled on that advocated by the OPW) is likely to be the most time- and cost-effective way to manage

risk when developing a climate change adaptation strategy.

4.1. Staged Risk Assessment

Staged risk assessment involves taking only the level of assessment required of the decision context and no more, leaving more detailed assessments for subsequent stages of planning and implementation. The OPW describes three stages as appropriate in such assessments, which may be translated as follows in the context of climate adaptation (OPW, 2009):

1. Climate risk identification: identify which climatic variables pose a sufficiently significant risk to warrant further assessment.
2. Initial climate risk assessment: assess the risks posed by identified climatic variables on an authority plan or proposed development site/activity. Seek out projections of change with respect to the specific variable or variables in question, determining to what extent projected changes have the potential to result in impacts that may exceed existing coping measures. Scope the requirement for further detailed assessment.
3. Detailed climate risk assessment: assess climatic risks in sufficient detail to provide a quantitative analysis of the potential impacts of climate change on a proposed or existing development or land to be zoned during its anticipated operational lifetime. Where such analysis highlights significant risks, or significant uncertainties as to future risks, adaptation measures should be proposed and assessed for their capacity to offset risk and uncertainty to a level in keeping with policy and legislative requirements.

Given the long-term, high-level nature of an adaptation strategy, only “Stage 1: Climate risk identification” is appropriate when appraising climate risk. Stages 2 and 3 of the risk assessment procedure must be employed only when specific plans or measures are to be implemented and more detailed information is necessary and is likely to be more readily available.

4.2. Climate Risk Identification

An identification of the climate risks that are likely to be of significance in the future should begin with those risks that are significant in the present. The adaptation baseline assessment in Chapter 2 produced a list of climatic events and trends deemed to have been of relevance in the recent past. This list can be used to guide an exercise aimed at identifying how relevant climate risks may evolve in the future.

4.2.1. The risk equation

Standard risk assessments use a relatively simple equation:

$$\text{Consequence} \times \text{Probability} = \text{Future Risk} \quad (4.1)$$

wherein “consequence” is the level of harm or damage caused by an event and “probability” is the likelihood of the event occurring. Risk is then typically calculated using a mapping of consequences against probabilities in a pre-calibrated matrix.

The elements of this equation can be readily translated for the purposes of a “Stage 1: Climate risk identification” exercise as follows:

- *consequence*: the estimated future level of service disruption caused by the climatic variable in question, giving an *impact consequence*;
- *probability*: the level of confidence attributable to projections of change in the climatic variable in question, giving a *projection confidence*:

$$\text{Future consequence} \times \text{Projection confidence} = \text{Future climate risk} \quad (4.2)$$

It should be noted that the long timeframes and uncertainties surrounding climate make an accurate calculation of probability very difficult. It is nevertheless possible to use judgements regarding climate projection confidence as a proxy for probability in the climate risk equation.

4.2.2. Using a climate risk matrix

The risk matrix illustrated in Figure 4.1 can be used to guide decision-making with respect to which climatic risks should be identified as being of particular significance for adaptation planning. To use it, estimate the “Future consequence” of a given climatic variable and the “projection confidence” attached to any projected change in the variable.

- Estimate future consequence: work from the average level of service disruption caused by a given climate variable (as categorised under the adaptation baseline assessment). Apply the projected change in the climate variable (e.g. such as those of Figure 4.2) to this baseline consequence, using the judgement of the team to determine to what extent future consequences may be lesser, the same or greater.
- Estimate projection confidence: not all climate projections will carry an explicit measure of confidence, but the supporting information offered with them typically provides ample scope for a confidence level to be estimated. Figure 4.2 is derived from publicly available projection sources, and illustrates how projections and their confidence levels might be estimated.

Box 4.1 shows a worked example of how a climate risk identification exercise might be carried out.

		PROJECTION CONFIDENCE				
		LOW 1	LOW/ MED. 2	MEDIUM 3	MED./HIGH 4	HIGH 5
FUTURE CONSEQUENCE	NEGLECTABLE	1	1	1	1	2
	MINOR	2	1	2	2	3
	MODERATE	3	2	3	3	4
	MAJOR	4	3	4	4	5
	CRITICAL	5	4	5	5	5

Figure 4.1. A climate risk matrix by which potential future risks may be identified.




























Climate impact projections: 30-year overview				
Variable	Summary		Confidence	Projected changes
 Sea Level Rise	 Strong increase	Sea levels are rising and will continue to do so for the foreseeable future.	 HIGH	Projections of SLR to 2100 suggest a global increase in the range of 0.09–0.88m with a mean value of 0.48m. For 2050 it is reasonable to assume a sea level rise in the region of 25cm above present levels. It should be noted that due to an as yet limited understanding of some of the important effects that contribute to rates of increase, these estimates of sea level rise may prove optimistic, and estimates of up to 4–6 m have been projected by some models
 Storm Surge	 Strong increase (N&W)	In the north-west, surges between 50 and 100cm will be 30% more frequent.	 MEDIUM	An increase in the number of intense cyclones and associated strong winds are expected over the north-east Atlantic. By the 2050s, storm surge heights in the range of 50–100cm are expected to increase in frequency for all coastal areas with the exception of the southern coast.
 Coastal Erosion	 Moderate increase	Increasing sea levels and wave heights may result in increased levels of coastal erosion .	 LOW	Currently approximately 20% of Ireland's coastline is at risk of coastal erosion, particularly areas of the south and east coast and also in isolated areas on the west coast. Rates of increase will be determined by local circumstances; however, it is expected that areas of the south-west are likely to experience the largest increases.
 Cold snaps/Frost	 Moderate decrease (winter/night)	Increasing average air temperatures may act to decrease the duration and intensity of cold snaps.	 HIGH	By mid-century, minimum temperatures during winter are projected to increase by ~2°C in the south-east and ~2.9°C in the north. This change will result in fewer frost days and milder night-time temperatures.
 Heatwaves	 Strong increase (summer)	Increasing average air temperatures are likely to increase the duration and intensity of heatwaves.	 HIGH	Seven significant heatwaves (defined as 5+ days @ >25°C) have been recorded in Ireland over the past 30 years, resulting in approximately 300 excess deaths. By mid-century, a projected increase in summer maximum daily temperature of approximately 2°C will likely intensify heatwaves, with maximum temperatures increasing and heatwave duration lengthening.
 Dry Spells	 Strong increase (summer)	Increased seasonality in precipitation is very likely to result in more severe dry spells in summer.	 MEDIUM	There have been seven periods of insignificant rainfall in Ireland in the past 40 years. Of these, the events of 1976 and 1995 were the most severe, averaging 52 and 40 days in duration respectively across Irish rainfall stations. An approximate 20% decrease in summer precipitation receipts in many areas is strongly indicated under a high emissions scenario. This decrease is likely to result in progressively longer periods without significant rainfall, posing potentially severe challenges to water-sensitive sectors and regions.
 Extreme Rainfall	 Strong increase (winter)	Increasing seasonality in rainfall distribution is likely to result in an a >20% increase in the number of very wet days.	 LOW	Heavy precipitation days (in which more than 20mm of rain falls) are likely to increase in frequency in winter. By the 2050s an increase in the number of heavy precipitation days of around 20% above the level of 1981–2000 is projected under both low–medium and high emissions scenarios. This may have serious consequences for flood risk in sensitive catchments.
 Flooding	 Moderate increase (winter)	Projected increases in winter rainfall will likely increase the risk of fluvial flooding in “fast response” catchments.	 LOW	An Irish Reference Network of hydrometric stations has been established to assess signals of climate change in Irish hydrology. This network has detected an increasing trend in high river flows since 2000. Projections of future flows are beset by uncertainties at the catchment scale, but a broad signal of wetter winters and drier summers is evident across a number of independent studies.
 Wind Speed	 Minor increase (winter)	Models predict a slight increase in wind energy in winter of between 0 and 8%, with a minor decrease in summer of 4–14%.	 MEDIUM	Observed wind speed over Ireland has not changed significantly in recent times, but it is anticipated that the distribution of wind will alter slightly in future, with winters marginally windier and summers marginally less so. Though the average windspeed is anticipated to change in only a minor way over the coming decades, the frequency of extreme wind storms is expected to increase due to alterations in the origin and track of tropical cyclones.

Figure 4.2. Estimates of projection confidence derived from published projection data.

Box 4.1. A worked example: How should the future risk posed by “dry spells” be prioritised by Authority X?

Baseline assessment: Authority X has found that in the past 30 years dry spells had, on average, resulted in a moderate disruption of the key services and functions it provides to the community.

Climate projection: in future decades, a strong increase in the severity of dry spells during the summer months is indicated.

Future consequence: the adaptation team discuss the potential ramifications of the projected increase in severity, determining that the average impact of dry spells is likely to increase from “moderate” to “major” in the event that the projection is correct.

Projection confidence: various confounding factors limit the extent to which the projection can be considered certain – local variations in precipitation patterns in particular hamper reliability. The confidence level of the projection is therefore deemed “Medium”.

Future risk: using the climate risk matrix, *major* future consequences under a *medium* projection confidence identifies future risk at Level 4: Major.

4.3. Prioritising Future Risks

Priorities attributed via the climate risk assessment matrix should be taken as a guide and may be adjusted in line with the specific conditions and concerns raised by local circumstances. The source material from which this risk matrix is derived suggests adjusting the boundaries between categories of risk where necessary, taking care not to overstate future risks when conducting an identification exercise (Department of the Environment and Heritage, 2006).

When the specifics of a risk identification schema have been agreed, priorities must be assigned to the future risks identified. Table 4.1 provides a guide as to the type of prioritisation that may be appropriate to the future risks identified.

Table 4.1. Future risk priorities

Future risk	Prioritisation
5: CRITICAL	Must <i>not</i> be accepted as part of routine (unadapted) operational procedures; urgent attention at the most senior level required; adaptation measures that function to diminish risk must be proposed and acted on immediately
4: MAJOR	May be accepted as a part of routine operations only where adaptation measures have been identified and are immediately feasible, monitoring/early warning of the risk is routine and the nature of risk is well understood; senior management must be informed of the status and evolution of the risk over time
3: MODERATE	May remain part of routine operations, but a schedule for future adaptation should be in place, with a thorough investigation of any lead time and/or required precedent steps prior to adaptation measures becoming feasible having been conducted
2: MINOR	Likely to remain part of routine operations; should be assigned a monitoring and observation protocol; existing controls are sufficient and no further action will be required unless significant change occurs
1: NEGLIGIBLE	No further action will be required in the short term unless significant change occurs in the climate variable or receiving environment in question

4.4. Setting Risk Management Objectives

Future risk must be managed in line with the broader policy objectives of the authority. However, the wide-ranging effects of climate change across the activities and functions of the authority makes determining objectives in relation to risk management a complicated task. What may be considered an acceptable level of risk in the realm of biodiversity or cultural heritage may be unacceptable with respect to waste or housing, with each area probably operating under the policy and performance targets set at higher levels of governance.

It is therefore essential to bring the adaptation team together to determine appropriate objectives for the mitigation of future risk. The work undertaken to complete Chapter 3’s adaptation baseline assessment will have highlighted those policies, regulations and legislative instruments of immediate relevance for managing climate risk. With these in mind, objectives should be set regarding the management of adaptation over the short, medium and long term.

- Where the objective carries a quantitative measure or threshold of performance (i.e. level of flood defences, water quality standards, etc.), these should be noted.
- The future level of risk considered acceptable once the adaptation measure has been enacted should be specified.

4.5. Horizon Scanning: Emerging Risks

A crucial element of an effective strategy is the capacity to anticipate and to respond flexibly to changing circumstances. It is therefore important to build the capacity to identify risks as they emerge, via changes in either the distribution/intensity of climatic stimuli or the sensitivity of the receiving environment. Monitoring and observation are therefore key elements in ensuring that emerging risks are tracked, as is the revisitation and reiteration of the strategy itself in order to ensure that the evolution of risk is understood.

Before moving on

Ensure that the evolution of risk is well understood, both within the team and, where appropriate, among senior management and the wider authority. Keeping a watching brief is a minimum requirement for future risk to be managed coherently, which will require dedicated resources in order to sustain long-term observation and data collection. Management buy-in over the long term is therefore essential.

Key outputs of Chapter 4 to include in the strategy

- A clear statement of future climate risks that must be addressed in the strategy.
- A detailed breakdown of those risks prioritised for immediate and future adaptation action.
- A statement of objectives in relation to the management of future climate risks.

5. Identifying, Assessing and Prioritising Options

Overview

With the risks posed by climate change prioritised, attention can be turned to the identification and assessment of appropriate adaptation options. Opportunities to work towards greater climate resilience over the medium to long term should be clearly identified and planned for at this stage of the strategy development process.

Key tasks of Chapter 5

- A range of potentially appropriate adaptation options must be identified.
- Options should be assessed for their ability to meet the objectives of the authority in adapting to climate change.
- Adaptation options should be prioritised for implementation.

adaptive measures lies in their level of quantification – in terms of both cost and anticipated efficacy. As they originate in the engineering and technology sectors, grey adaptation options are typically more conducive to rigorous substantiation of their anticipated benefits and limitations, often in the form of quantitative modelling. Given the relatively high levels of capital outlay required to facilitate their use, this level of justification is often a prerequisite for their implementation. Nevertheless, the limitations in predictive modelling of complex and dynamic natural systems should be borne in mind when selecting between grey options and soft or green alternatives. Much of the apparent certainty and rigour of grey options is derived from modelled hypotheses and is thus subject to error.



Figure 5.1. Grey adaptation in practice: sea wall installation in Shetland (image: Tulloch Developments Ltd). Reproduced courtesy of Tulloch Developments Ltd (www.tullochdev.co.uk).

5.1. Identifying Adaptation Options

Adapting to climate change need be no more novel or complex than any other task of local governance. Many of the adaptation options available to planners and policymakers at the local scale are already in use in some form, requiring little more than a change in the scale or focus of existing management efforts in order to orient them towards greater climate resilience. This is reflected in the way in which adaptation options have typically been categorised to date, with modes of adaptation delivery – termed “grey”, “green” and “soft” – largely originating in existing measures and practices.

5.1.1. Grey adaptation

“Grey” adaptation typically involves technical or engineering-oriented responses to climatic impacts. Examples of grey adaptation include the construction of sea walls or tidal barrages in response to a sea-level rise (Figure 5.1), or the replacement of traditional sprinkler systems with drip-feed irrigation schemes in the face of water shortages. A key advantage of these

5.1.2. Green adaptation

“Green” adaptation options are those that seek to use ecological properties to enhance the resilience of human and natural systems in the face of climate change. Green options include efforts to reinstate dune systems to act as buffers against coastal storm damage, or the creation of green spaces and parks in an effort to counteract the urban heat island effect.

A potential drawback of green adaptation options can be their relatively long lead times, given the timescales often required to establish fully functional natural systems. However, green options perform particularly strongly in providing ancillary benefits beyond pure climate impact amelioration, often serving to offset or diminish carbon emissions, while providing desired social or ecological services such as enhanced recreation or biodiversity preservation. Green options also typically perform equally strongly across a number of climate scenarios. As explained further in section 5.2, these considerations form critical elements in the determination of which adaptation option is most appropriate to a given adaptation context.

5.1.3. *Soft adaptation*

“Soft” adaptations involve alterations in behaviour, regulation or systems of management, such as land-use planning policy. As such, soft measures have the potential to be relatively flexible and inexpensive to progress. They are therefore often considered the most tractable first steps in taking action on climate adaptation.

Examples of soft adaptation in practice include the amendment of building standards to account for increased flood risk, or public education schemes that aim to enhance the capacity of vulnerable sectors of the population to cope with extremes of heat. Soft adaptation is attractive for its apparent ease of implementation, but suffers the drawback of requiring substantial effort in terms of on-going support, policing or regulatory oversight in order to ensure substantive change in behaviour is effected and maintained over time.

5.1.4. *Examples of adaptation in practice*

There are a growing number of European countries in which adaptation processes have progressed beyond initial, exploratory phases of vulnerability and/or risk assessment towards the implementation of adaptation options. These early experiences of adaptation in practice are now being:

- collated into databases;
- described in illustrative texts; and
- analysed within guidelines for the generalisable insights that they may offer to others.

This burgeoning adaptation knowledge base can be used to provide sources of inspiration and experiential learning, allowing decision-makers at the local scale to select from a wide array of grey, green and soft options in determining which adaptation measures to take forward for further assessment and scrutiny. However, the experiences of other decision-makers in other decision contexts can be generalised only to a point; ultimately, adaptation decision-making on the ground must be guided by the same combination of resource availability, higher level policy constraints and local stakeholder interests that determine all other fields of local governance.

5.2. **Assessing Adaptation Options**

The range of options available to those seeking to adapt to climate change is rich and diverse, spanning complex and innovative engineering such as the floating flood-resilient homes on the River Maas in the Netherlands (Figure 5.2), to relatively simple, long-term shoreline management plans such as those employed in England and Scotland. Either or both of these adaptations might be implemented to increase local resilience to sea level rises.



Figure 5.2. How to adapt? Floating homes on the river Maas in the Netherlands (image: Dura Vermeer). Reproduced courtesy of Dura Vermeer (<http://en.duravermeer.nl>) and Inhabitat.com (www.inhabitat.com).

Determining which adaptive measures should be implemented, and where, when and by whom, typically involves a complex process of planning and negotiation. Table 5.1 offers a number of key questions that can help to determine how options may be assessed.

Table 5.1. Evaluating adaptation options: decision factors and key questions

Factor	Key questions
Adaptation EFFICACY	How effectively can the option address the climate impact in question?
Extent and types of COSTS	What are the option's up-front investment costs? What are the option's upkeep or on-going maintenance costs? What are the option's non-economic (social and/or environmental) costs?
Technical, social and institutional COMPLEXITY	How complex is the option to implement? How complex is it to maintain or support the option on an on-going basis once implemented? How complex will an exit or transition from the option be in the future?
Decision SCALE	Does the decision for or against implementation of the option lie principally with the local authority? Must the state play a part in or agree to the implementation of the option? Must stakeholders at lower levels of governance make a contribution to the option's implementation or upkeep?
Level of REGRET	<i>Low regret:</i> are the option's implementation costs relatively low, while providing relatively large benefits under projected future climate impact regimes? <i>No regret:</i> is the option cost-effective under existing conditions, capable of addressing projected future climate impacts and free of hard trade-offs with other policy objectives? <i>Win-win:</i> does the option contribute to climate adaptation while also providing other socio-economic or environmental benefits, including climate change mitigation?
MITIGATION co-benefit	Will the option offer the potential to reduce atmospheric CO ₂ , either by lowering emissions or by providing carbon sinks?
FLEXIBILITY	Does the option provide the scope to respond with agility to the emergence of new information? Will it create long-term lock-in to a given course of action or is it sufficiently flexible to allow relatively swift and cost-effective change?

5.2.1. Adaptive decision-making: key constraints

At local authority level, government policy, resource availability and local-level interests are typically the critical constraints on adaptation decision-making. In

the short term, assessing which adaptation option (or options) are appropriate might therefore become a relatively straightforward task:

- Policy at national or regional level might unambiguously rule in or out the selection of certain options (or even entire categories of options).
- The limitations imposed by funding restrictions alone may rule out many adaptation alternatives that have been attempted elsewhere.
- Local sensibilities may be clearly disposed towards the use of one approach over another.

In the short term, these factors may create a bottleneck, wherein the only course of action open to decision-makers at the local scale is the perpetuation (or minor amendment) of measures already in place. It should be noted that so long as a robust and well-resourced programme of monitoring is in place (or can be instituted) to track the efficacy of these measures in the face of climatic impacts, the perpetuation of existing measures could be legitimately included within the strategy as early-stage adaptation.

However, broadening this bottleneck over time to allow for the selection of options that provide greater resilience in the face of change is a central aim of adaptation and should be pursued.

5.3. Prioritising Adaptation Options

The prioritisation that an option receives in an adaptation strategy will come down to a number of factors, including:

- the priority accorded to the risk that the option is intended to address;
- the relative merits of the option compared with those of alternative options;
- the degree to which the option provides integration of adaptation benefit across the various internal policy areas of the authority;
- as far as can be gauged, the degree to which the option supports the adaptive efforts of those external to the authority.

Timeliness should also be a critical factor in determining adaptation priorities. There may be opportunities to implement adaptation measures either in conjunction

with, or as part of, already planned schedules of maintenance, renewal or review. These opportunities should be exploited wherever possible, as they may not only lower implementation costs but may also allow adaptation to be effectively brought into the mainstream operations of the authority.

Those options that may not be considered appropriate for prioritisation in the short term may nevertheless be worthy of further consideration in future. The constraints under which adaptation must be pursued will probably alter markedly in future, as both the impacts of climate change become more severe and societal conceptions of acceptable climatic risks evolve. Prioritising adaptive measures for the medium to long term that perform more robustly but that perhaps involve greater commitment, upheaval or cost will enhance the long-term validity of the strategy.

Before moving on

Build a broad understanding of what the various options are under each of the identified future risks of relevance to the authority. Be clear on what each offers, the circumstances under which each might be appropriately pursued, and the inherent trade-offs involved in doing so. It is important to also bear in mind that the options that most closely fit the needs and constraints of the present are by no means guaranteed to be those that will do so in the future, even over relatively short timescales. For this reason alone, having a strong and well-selected suite of options, and the depth of knowledge required to discern when and how they might best be employed, is crucial.

Key outputs of Chapter 5 to include in the strategy

- A list of adaptation options with the potential to enhance climate resilience in the face of identified future risks.
- A structured appraisal of each option in line with robust adaptation selection criteria.
- A clear and reasoned prioritisation of options to pursue in the short, medium and long term.

6. Developing Pathways and Drafting a Strategy

Overview

The bulk of the work required in developing an adaptation strategy has now been completed. The final stages of the process involve bringing together the outputs of future risk identification and option selection to develop a strategy for the future that builds on a sound understanding of baseline conditions. A useful framework around which the various elements of the strategy might coalesce is an adaptation pathways map. Developing a map is thus the first task of this chapter, with the aim that it will facilitate the subsequent drafting of an adaptation strategy.

Key tasks of Chapter 6

- Compile and review the various outputs from Chapters 2–5.
- Develop an adaptation pathways map.
- Draft an adaptation strategy.

6.1. Building an Adaptation Pathways Map

The work of Chapters 2–5 will have provided a base of knowledge and contextual information that can now be linked together to facilitate future planning. An adaptation pathways map is a useful means by which to structure and subsequently communicate this information (Siebentritt et al., 2014).

An adaptation pathways map is simply a schematic of adaptation options and the relationships between them; it is similar in nature to a decision tree. The map starts at the present and plots multiple different pathways to the future, each employing a different combination of adaptation options.

The advantages of adopting an adaptation pathways approach include the following (Moss and Martin, 2012):

- Managing uncertainty: pathways facilitate a structured modification of adaptation response in light of new information, changing circumstance or societal priorities.
- Transparency: pathways make explicit the assumptions, trade-offs and aims of adaptation efforts in a way that is readily communicable.
- Risk-based decision thresholds: thresholds of acceptable risk determined during prior steps of the strategy development process can be explicitly used as decision trigger points, with alternative adaptation measures being flagged as necessary when risk thresholds are reached.

In order to build an adaptation pathways map, decisions must be taken with respect to how and when adaptation options are likely to be available to employ and, similarly, how and when climate risks are likely to evolve in the future.

6.1.1. Building a pathways map: key questions

For each of the adaptation options that have been prioritised for implementation over the short, medium or long term, estimate the time periods before the option will be available, how long it must be in place before alternative choices can be taken up and at what point the option is likely to become ineffective – the “before”, “during” and “after” of pathway planning.

1. BEFORE: when will the option come online as an effective adaptation measure?
 - (a) Are there any technological, social, economic, political, legal or environmental obstacles to its implementation? If so, what must be done in order for them to be overcome?
 - (b) Are there any key prior dependent steps that must be taken in order to make the option viable? If so, what are they and when are they likely to be taken?
 - (c) Is there a known lead-in period during which the option will not be fully effective?

2. DURING: once implemented, how long will the period of the option's operational lifetime be before an opportunity to change to a different pathway becomes available?
 - (a) Is the option path dependent (i.e. is it uneconomic or even physically impossible to change course from once in place)?
 - (b) Does the option have natural windows of opportunity in which re-evaluation and change are possible?
 - (c) Will it be possible to incrementally enhance the capacity of the option to cope with climatic impacts?
3. AFTER: what is the impact threshold at which the option is unlikely to continue to be viable?
 - (a) Is there an identifiable upper limit at which the option is likely to be overwhelmed (such as a flood level, surge height or duration of drought)? Where such a limit is identifiable, it should be linked to an approximate point in the future at which the upper limit is likely to be realised.
 - (b) If no upper performance limit is identifiable, is there an inherent operational lifespan at which the option must be replaced?
 - (c) Is it possible to gauge the time period until any impact threshold affecting the performance of the option is likely to be reached?

An example of how these key questions might be answered is provided in Table 6.2, with an illustration of how the responses might be formed into a graphical pathway map in Figure 6.1.

6.2. Plotting a Preferred Route

Each identified climate risk should have an associated adaptation pathways map, outlining a range of potentially plausible adaptation options and how they may be selected for implementation over time. Although it will not yet be possible to determine with certainty how the future will unfold, plotting a preferred route through each pathways map can provide direction to the planning processes that will follow as the strategy is implemented. The preferred route should thus be aspirational.

6.3. Bringing It All Together: Drafting an Adaptation Strategy

The information gathered through the previous steps of the strategy development process can now coalesce to provide a framework for the adaptation strategy. For each identified climate risk, the options plotted on each pathways map, and the preferred route through it, will form the basis of each "Adaptation actions" section of the draft strategy.

The strategy must focus on the achievement of high-level, long-term adaptation goals and objectives. Examples of this type of foresight-oriented strategy at the local–regional level are now becoming increasingly numerous. Table 6.1 gives a brief overview of published strategies that provide examples of good practice.

Table 6.1. Examples of adaptation strategies that may serve as useful templates for local authority adaptation planning in Ireland

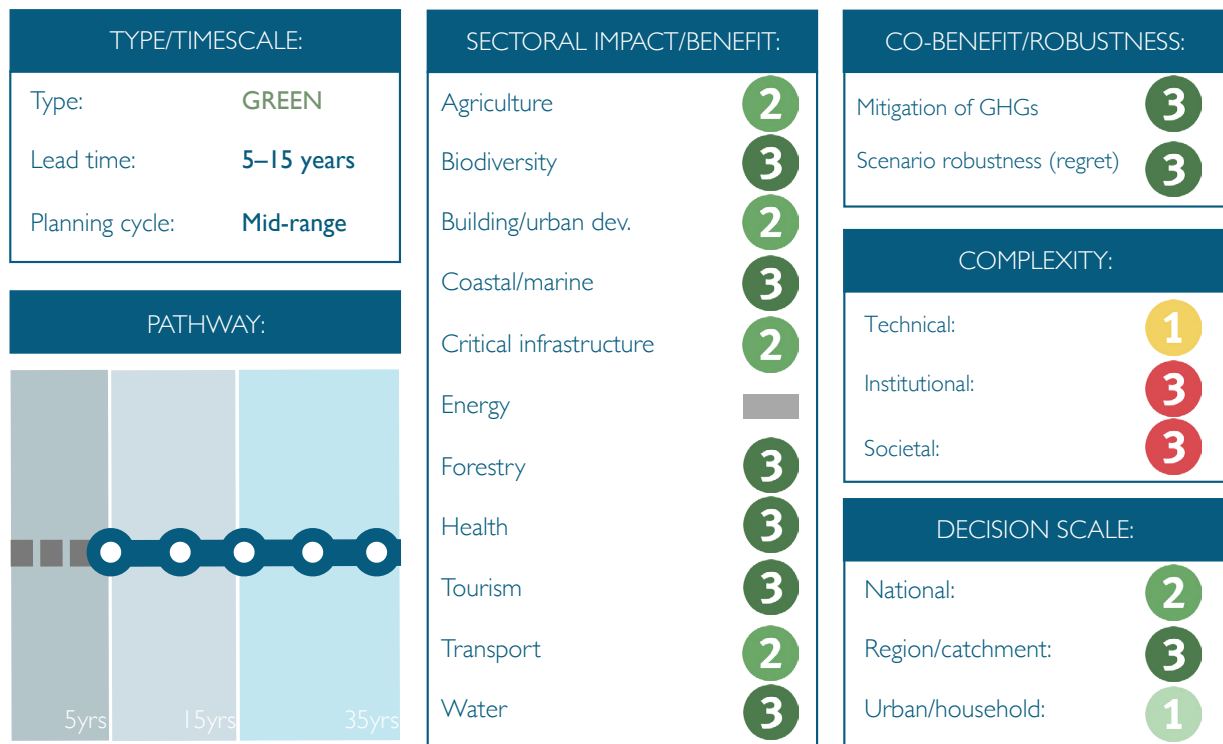
Case study: Key strategy highlights	
Vancouver	Quantification and assessment of risk Selection and evaluation of adaptation measures Parsimony and clarity in handling of impact and adaptation response planning
London	Mapping and allocation of adaptation roles and responsibilities Cross-sectoral climate impacts and adaptation interdependencies "Roadmap to resilience", offers a clear and concise set of actions to enhance adaptive capacity in the face of future climate risk
King County	Long-standing example of best practice, illustrating how a mature strategy can develop over time Integration of climate change mitigation and adaptation issues and their management Provision of clear adaptation objectives linked to tractable actions to enable their achievement
Eyre Peninsula	Acknowledged as a leading example of knowledge integration in support of adaptation, bringing stakeholders from diverse fields and backgrounds together to co-create a strategy for the future that all could support Takes a regional, multijurisdictional approach to adaption planning Works across traditional disciplines and roles to achieve holistic adaptation solutions Uses the adaptation pathways approach to facilitate future planning in a way that is readily accessible and communicable, yet sufficiently robust and flexible to provide significant resilience to climatic impacts over time

Regenerate/preserve vulnerable wetlands

- Wetlands are valuable natural areas that are difficult to re-create, and provide a number of critically important ecosystem services. As a result, current and future efforts are warranted to protect these areas.
- Wetlands naturally trap and then slowly release precipitation and surface water over floodplains, thereby lowering flood heights and dissipating storm surges.
- Wetland vegetation stabilises the shoreline by holding sediments in place with roots absorbing wave energy and slowing the flow of stream or river currents.
- Wetlands also reduce pollution of waterways, by storing and filtering nutrient inputs, and play a key role in recycling these nutrients into usable substances.



Wetlands provide natural defences against the effects of coastal erosion and inundation as a result of surges and extreme tides (image: branford-ct.gov).



BOTTOM LINE: The preservation of coastal wetlands has many positive effects, regardless of its utility for climate change adaptation. Wetlands are among the most productive ecosystems on earth and contribute to a diversity of plants of animals by providing fish and wildlife with, among others, breeding, nesting and nursery grounds. As such, wetlands can generally be considered a tourist attraction. The preservation of wetlands nevertheless means less space for development and thus impacts upon the majority of sectors.

Figure 6.1. A hypothetical adaptation pathway for the implementation of a wetland buffer to offset flood risk on a given stretch of river.

Table 6.2. Defining key points in an adaptation pathway by estimating the length of time before the option will become feasible, the flexibility of the option with respect to the potential to opt in or out of its implementation and the time at which it is no longer likely to remain an effective adaptation measure in the face of changing climate impacts

Example: Wetland creation as an adaptation option for flood risk management				
Pathway questions		Description	Approximate timescale	Pathway period
1. BEFORE	a. Obstacles?	A detailed study must be undertaken to determine where an appropriate site for a wetland buffer might best be located	≈1 year	~5–6 years
	b. Prior dependent steps?	Space in which to develop the wetland buffer zone must be procured	≈2 years	
	c. Lead-in period?	The wetland will take a number of years to become a fully functional buffer against flooding	≈2–3 years	
2. DURING	a. Path dependency?	There is no long-term lock-in to maintaining the area as a wetland; draining and defending the area from water ingress will make it appropriate for alternative uses again within a short period of time	< 1 year	≈6 years
	b. Opt-out windows?	There are unlikely to be any specific windows of opportunity to change course that are more favourable than others; therefore, opt-out can be assumed to be taken to be continuously available. However, a decision regarding the designation of space for areas such as wetlands is most appropriately taken via statutory land-use planning, carried out on a rolling 6-year basis	≈6 years	
3. AFTER	a. Upper performance limit?	YES: it is likely that an estimate of the maximum capacity of the wetland to buffer against downstream flooding could be calculated, in turn providing a time period at which projection data indicate that the limit may be exceeded	≈20–30 years	≈20–30 years
	b. Lifespan?	NO: wetlands are naturally self-maintaining and if undisturbed will survive for the foreseeable future		
	c. Incremental capacity increase possible?	There may be some scope to increase the area given over to wetland in response to changes in flood risk estimates; doing so would enhance the lifespan of the wetland as an effective adaptation option, but would require further study and the procurement of further space (at ≈3-year lead in)	?	

6.3.1. *Be comprehensive, but succinct*

Table 6.3 suggests content for each section of the strategy. The aim is to provide a relatively brief, broad and long-term strategic guide to operational decision-making processes taking place over shorter timescales. A detailed analysis of each adaptation option can be undertaken more coherently at the time at which a decision is taken to implement it. The strategy should instead aim to provide a suite of options to choose from in making a final decision.

6.4. **Moving from a Working Draft to a Plan of Action**

A working draft of the strategy should be circulated for discussion among and assessment by the adaptation team. At this stage, the focus should be on ensuring that the strategy as it stands can form a coherent basis for subsequent actions to be taken.

With this in mind, the team should come together to set out a clear plan for the implementation, monitoring and review of the strategy in advance of presenting it to key stakeholders and senior management for formal adoption.

Table 6.3. Suggested content of a local authority adaptation strategy

Strategy section	Suggested contents	Approximate length
1. Background and methodology	<p>Introduction: a brief contextual overview of why adaptation at local authority level is a priority consideration and what its high-level goals are</p> <p>Briefly state how the strategy was developed, including:</p> <ul style="list-style-type: none"> • which other authorities were collaborated with in the development of the strategy • which sectors were collaborated with in the development of the strategy • which external stakeholders were engaged in the development of the strategy • how internal and external collaboration was facilitated throughout the strategy development process <p>Acknowledge the contribution of adaptation team members and any other internal/external contributors to the strategy</p>	2–3 pages
2. Adaptation baseline assessment	<p>Give a brief overview of the extreme events and climatic trends that have been of particular relevance to the strategy</p> <p>Discuss briefly the context in which decisions are taken with respect to managing the impacts of these events and trends, describing those policies/legislative instruments of relevance and what they entail and plans and measures currently in place and their anticipated lifespan/thresholds of performance</p> <p>Provide a prioritisation of climatic impacts of relevance to the local authority, describing briefly how it was arrived at</p>	2–3 pages
3. Climate risk identification	<p>Give a statement of identified future climate risks, making reference to what the current impacts of the climate variable in question are and how climate projections suggest it will change in the future.</p>	1 page
4. Adaptation actions	<p>For each identified climate risk, provide:</p> <ul style="list-style-type: none"> • the authority's objectives in relation to the future management of the risk • a brief description of the adaptation options available to offset the risk • an adaptation pathways map outlining how the risk might be appropriately managed over time • a statement as to current thinking regarding the most appropriate route through the pathways map • a statement of what will be (or has already been) implemented as early stage adaptation in response to each risk, and how these measures might be effectively linked to the preferred adaptation pathway in future 	1 page per risk category
5. Implementation, monitoring and evaluation	<p>Give a general overview of how the implementation of adaptation options will be managed, referring to spatial planning mechanisms, instruments of local policy implementation and SEA as appropriate</p> <p>Describe the mechanisms put in place to monitor the impacts of climatic events and trends as they occur</p> <p>Describe the scheduling of evaluation of the strategy, including via reference to impact thresholds if exceeded</p>	1–2 pages

Before moving on

At this stage of the process, the majority of the strategy is in place, with the anticipated direction that adaptation should take becoming increasingly clear. Determining how the preferred paths to climate resilience can be realised is the task of the next and final chapter.

Key outputs of Chapter 6 to include in the strategy

- Adaptation pathway maps illustrating viable adaptation measures.
- A preferred route through each pathway.
- An overarching framework document setting the context for each pathway (the strategy itself).

7. Implementation, Monitoring and Evaluation

Overview

Having made progress towards determining what robust adaptation might entail, it is now essential to clarify how and when the first steps towards implementing adaptation options should be taken, and how decisions regarding future adaptation might best be informed by events as they unfold.

Key outputs of Chapter 7 to include in the strategy

- Implementation plan.
- Monitoring routine.
- Schedule of evaluation and review.

7.1. First Steps: Minor Amendments to Existing Measures, Plus Monitoring

The first actions described in the adaptation strategy are in most cases likely to be centred on policies, procedures and plans that are already in place. These will have been identified during the baseline assessment, along with their anticipated duration and adaption role categorised for the purposes of adaptation pathway mapping. Unless it is considered both desirable and feasible to attempt a sharp change of direction, these policies and measures will form the basis of early-stage adaptation. What should, nevertheless, be explicitly accounted for within the strategy is:

- any change in the extent or emphasis of existing measures in response to identified climate risks; and
- a systematic method of monitoring the efficacy of these measures in the face of climatic impacts.

Implementation of the strategy in these instances will involve simply documenting what has occurred and ensuring that adequate monitoring and evaluation processes are instituted (see section 7.3).

7.1.1. *The importance of documenting action*

Adaptation progress must be evaluated (and in all likelihood in the near future, reported on) (Desmond, 2014). A crucial element of the implementation process should therefore be to ensure that the options to be implemented in the short term (even where such implementation pre-dates the strategy and is thus in place) are adequately documented within the strategy. How these actions are anticipated to effectively lead on to those desired in the future should also be clearly stated, referring to the adaptation pathways map as appropriate.

7.1.2. *Implementing new measures*

If there are new adaptation measures or substantial deviations from normal operational procedures that must be implemented immediately, a clear delineation of roles and responsibilities both internal to the authority and among external stakeholders should be made within the strategy.

Although those responsible for effecting change are likely to be best placed to determine how exactly it should be implemented, there are a number of supporting mechanisms, policies and institutions available to assist local authority adaptation efforts. These range from policy and legislation that will legitimise the reallocation of resources, to specific funding mechanisms that could be employed to ensure the continuity of adaptation maintenance and monitoring over time, including:

1. International/EU mechanisms:

- (a) United Nations Framework Convention on Climate Change (<http://unfccc.int/adaptation/items/4159.php>);
- (b) Hyogo Framework (<http://www.unisdr.org/we/coordinate/hfa>);
- (c) EC Civil Protection Mechanism (<http://ec.europa.eu/echo/en/what/civil-protection/mechanism>);
- (d) EC Adaptation Strategy (http://ec.europa.eu/clima/policies/adaptation/what/documentation_en.htm);

- (e) EC Water Framework Directive (EC, 2000: http://ec.europa.eu/environment/water/water-framework/index_en.html);
- (f) EC Floods Directive (EC, 2007); (http://ec.europa.eu/environment/water/flood_risk/);
- (g) EC Habitats Directive (http://ec.europa.eu/environment/nature/legislation/habitats_directive/index_en.htm);
- (h) LIFE Programme (<http://ec.europa.eu/environment/life/>).

2. National mechanisms:

- (a) NCCAF (<http://www.environ.ie/en/Publications/Environment/ClimateChange/FileDownLoad,32076,en.pdf>);
- (b) Sectoral Adaptation Plans prepared under the NCCAF;
- (c) Climate Action and Low Carbon Development Bill; (<http://www.environ.ie/en/PublicationsDocuments/FileDownLoad,32468,en.pdf>);
- (d) Catchment Flood Risk Assessment and Management programme (<http://www.cfram.ie/>).

7.2. Future Steps: Implementing Medium- to Long-term Adaptation

In addition to the mechanisms listed above, over the medium to long term, statutory planning processes offer considerable potential as vehicles of adaptation implementation (Gleeson *et al.*, 2013). Much of what adaptation seeks to enhance or amend is already subject to planning legislation, thereby creating clear synergies between plan making and the implementation of preferred adaptation options.

The work undertaken to develop a local adaptation strategy should inform development plans and other statutory plans of the local authority. Where adaptation measures arising from the strategy are incorporated into a plan, the SEA process will provide a natural mechanism to highlight and assess these actions and their

probable impacts on the environment. The adaptation strategy should provide the overarching, long-term view that SEA processes require, and significantly reduce the burden of cumulative impacts assessment given the integrated nature of the analysis underpinning it.

It will be a matter for the local authority to decide whether or not the adaptation strategy would need to undergo a separate SEA process.

7.3. Monitoring and Evaluation

As described in section 5.2, the early phases of the strategy may simply involve the monitoring of measures that are already in place for their efficacy in coping with climatic impacts as they arise. Employing the same procedures as those that were used to determine the impacts of past extreme events and trends will provide a directly comparable measure of adaptation performance over time. For instance, in the immediate aftermath of an extreme weather event, assess the level of disruption it caused (by convening the adaptation team). If the same criteria are employed to evaluate impact and cost data, adaptation efficacy can be tracked throughout the life of the strategy. Setting a schedule at which the team is convened to assess the impacts and costs (or benefits) of climatic trends will serve a similar purpose.

7.3.1. Evaluating and review of the strategy

The strategy will encompass a period of approximately 35 years. A new strategy should be drafted every 10 years, with a 5-year review point to determine the strategy's continued relevance and performance against adaptation objectives.

7.4. Finalising the Draft Strategy

The strategy should be presented in draft form to key stakeholders and senior management for amendment and validation. Formal adoption of the strategy should follow, with the schedule of implementation, monitoring and review appended.

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Abbreviations

CAP	Common Agricultural Policy
CFP	Common Fisheries Policy
CO₂	Carbon dioxide
EC	European Commission
EPA	Environmental Protection Agency
EU	European Union
GHG	Greenhouse gas
GIS	Geographical Information System
HSE	Health Service Executive
IPCC	Intergovernmental Panel on Climate Change
NCCAF	National Climate Change Adaptation Framework
OPW	Office of Public Works
SEA	Strategic Environmental Assessment
SLR	Sea level rise

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL

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

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

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

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

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

Ár bhFreagrachtaí

Ceadúnú

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

- saoráidí dramhaíola (*m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola*);
- gníomhaíochtaí tionsclaíocha ar scála mór (*m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta*);
- an diantalmhaíocht (*m.sh. muca, éanlaith*);
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géimhódhnaith (*OGM*);
- foinsí radaíochta ianúcháin (*m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha*);
- áiseanna móra stórála peitрил;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil

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

Bainistíocht Uisce

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

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaoil

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

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn

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

Taighde agus Forbairt Comhshaoil

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

Measúnacht Straitéiseach Timpeallachta

- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaoil in Éirinn (*m.sh. mórfhleananna forbartha*).

Cosaint Raideolaíoch

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

Treoir, Faisnéis Inrochtana agus Oideachas

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

Múscailt Feasachta agus Athrú Iompraíochta

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

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil

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

- An Oifig um Inmharthanacht Comhshaoil
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Fianaise is Measúnú
- An Oifig um Cosaint Raideolaíoch
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

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

Author: Stefan Gray

Background

Ireland is vulnerable to the adverse effects impacts of global climate change, which will have diverse and wide ranging impacts on the environment, society, economic sectors and natural resources. These impacts are expected to increase over the coming decades. Effective actions are needed to reduce vulnerabilities to the negative impacts of climate change, take advantage of any opportunities.

The policy responses to climate change are two- fold:

1. Mitigation of emissions of the GHGs that are driving climate change
2. Adaptation to the adverse impacts of climate change

Climate change adaptation consists of actions that respond to current and future climate change impacts. As the impacts of climate change vary spatially, adaptation requires locally specific, place-based responses, which address climate impacts but also integrate coherently with the local fabric of social, economic and ecological systems. High-level adaptation policy is typically developed by central government but local differences make adaptation decision-making the concern of regional and local scale administrators, businesses and public.

Identifying pressures

It is beyond doubt that the impacts of climate change are already being experienced across Ireland and around its coast.

The challenge now is to provide local level decision makers with the knowledge, tools, know-how and capacity required to develop and implement adaptation strategies which will be resilient to the impacts of climate change.

The research report provides a set of Local Authority Adaptation Strategy Development Guidelines which will support Local Authorities in the development of a local climate change adaptation strategy. In its structure and content, the guideline draws heavily on the 2013 'Guidelines on developing adaptation strategies' provided to EU Member States by the European Commission with the aim of fostering coherence between strategies developed at local and national scale.

Informing policy

The key components from these guidelines will assist in the development of coherent and rational decision making based on an adaptive management planning cycle, namely by:

- Outlining the initial steps required in launching a strategy development process, describing key roles and who can fulfil them, and setting out important factors to consider at the early stages of strategy development
- Explaining how to assess the role that weather extremes and climatic trends currently play within the local jurisdiction, and describes why doing so is a fundamental element of working toward a more climate resilient future
- Identifying future climate risks, describing a staged risk assessment process and positioning the adaptation strategy within more detailed risk assessments undertaken during shorter term decision making processes such as statutory plan-making
- Describing the types of adaptation options that are available to address the risks identified in the previous chapter, and outlines how each might be assessed and prioritised for implementation
- Outlining the steps required to move from a phase of planning to one of implementation, and explaining the importance of monitoring and evaluation in ensuring the strategy is achieving its anticipated adaptation outcomes

Developing solutions

The research provides Ireland with a set of local authority adaptation strategy development guidelines, which will build capacity at the local level for effective climate change decision making.

