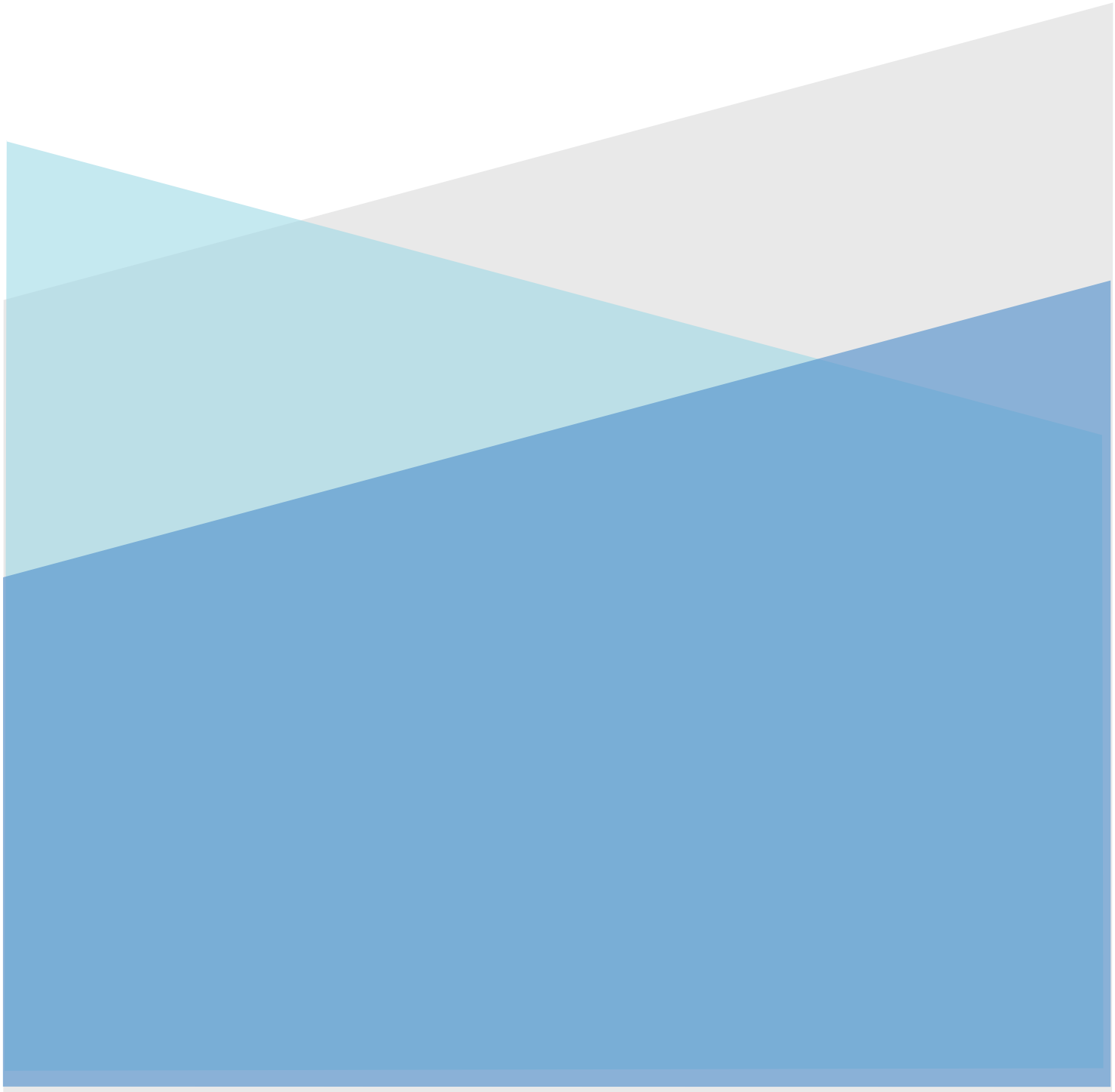
Roinn Cumarsáide, Gníomhaithe
ar son na hAeráide & Comhshaoil
Department of Communications,
Climate Action & Environment

Sectoral Planning Guidelines for Climate Change Adaptation

May 2018



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Foreword by Minister

The global community, including Ireland, is responding to a changing climate by focusing our efforts on lowering our greenhouse gas emissions. However, equally challenging is the scenario of where a changing climate will continue to impact long after global emissions have been stabilised.

Earlier this year, I published Ireland's first statutory National Adaptation Framework (NAF) which sets out the role key sectors will have in developing climate resilience for Ireland through planning for climate change adaptation. A key action under the Framework is the publication of Sectoral Planning Guidelines for Climate Change Adaptation.

The NAF seeks to a deliver a coherent whole-of-government approach to resilience in line with both the National Development Plan 2018-2027 (NDP) and the National Planning Framework (NPF) which share a set of National Strategic Outcomes, including addressing Ireland's transition to a low-carbon and climate-resilient society. In this regard the funding commitment of €21.8 billion towards climate action investments within the NDP is very welcome.

Adaptation planning is a new challenge for most Government Departments and will require new skillsets and capacities to be developed within Government Department and Agencies over time. I strongly believe that we now have enough information available to us to begin the adaptation planning process in Ireland.

I therefore very much welcome the publication of these Sectoral Adaptation Guidelines and would like to thank everybody who contributed to their development, including the sectors themselves but also colleagues in both the Environmental Protection Agency (EPA) and the MaREI Centre for Marine and Renewable Energy in UCC. It is crucially important that consistent and coherent guidance on climate change is provided by Government in order to assist with our transition to a climate resilient Ireland and these guidelines deliver on that ambition.

The principles and process outlined in these Guidelines have relevance for most public sector organisations however the Guidelines will be particularly important in supporting the 12 sectors identified in the NAF in developing sectoral adaptation plans under the Climate Action and Low Carbon Development Act 2015 (the Climate Act). The Guidelines were

originally developed by MaREI under “Climate Ireland”, a project which had its beginnings under the EPA’s Climate Research Pillar and which has been further developed with substantial input from the Government Departments and Agencies that will be required to use them.

The Guidelines have been developed to ensure that they are flexible enough to be applied across all sectors and to take sectoral specific challenges into account. The Guidelines provide a consistent and coherent process for Government Departments and Agencies to develop sectoral adaptation plans under the Climate Act and ensure that appropriate adaptation actions will be developed at sectoral level over the long term.

Building a climate resilient Ireland will be a long term process that will require a sustained and planned response over the long term and these guidelines represent a crucial support for the sectors tasked with taking our first steps in preparing Ireland for an effective climate resilient transition.

Denis Naughten, T.D.

Minister for Communications, Climate Action and Environment

Executive Summary

Ireland's first statutory National Adaptation Framework (NAF) was published in January 2018. The NAF sets out the national strategy to reduce the vulnerability of the country to the negative effects of climate change and to avail of any positive impacts. The NAF was developed under the Climate Action and Low Carbon Development Act 2015.

The NAF outlines a whole of government and society approach to climate adaptation in Ireland. Under the NAF a number of Government Departments are required to prepare sectoral adaptation plans in relation to a priority area that they are responsible for and the formalisation of adaptation planning guidelines to assist in the development of these plans is a key action under the NAF.

Therefore, these *Sectoral Planning Guidelines for Climate Change Adaptation* have been developed for, and are primarily intended for the use of, the sectors required to prepare statutory sectoral adaptation plans under the Framework. The guidelines were originally developed as part of an Environmental Protection Agency (EPA) research project ('A Climate Information Platform for Ireland') with funding provided by the Department of Communications, Climate Action and Environment (DCCAE). The guidelines are based on international best practice (e.g. EEA, 2013; Gray, 2015; Buth et al. 2017) and were developed in close consultation with the Department of Transport, Tourism and Sport (DTTAS), the Department of Agriculture, Food and the Marine (DAFM) and other key sectors tasked with the preparation of sectoral adaptation plans.

The guidelines aim to ensure that a coherent and consistent approach to adaptation planning is adopted by the key sectors in Ireland. Sectors preparing sectoral adaptation plans under the NAF are required to prepare their plans in line with the process described in these guidelines while also being aware of the overall requirements regarding the development of sectoral adaptation plans in Sections 5, 6 and 7 of the Climate Action and Low Carbon Development Act 2015 and the NAF (particularly Chapters 3 and 4).

The guidelines are based on a staged and proportionate approach to adaptation planning and are structured around a 6 step planning cycle, these are:

1) Preparing the Ground;
2) Climate Impact Screening;
3) Prioritisation;

4) Priority Impact Assessment;
5) Develop your Plan;
6) Implement, Evaluate and Review.

Figure 1 shows these steps in sequence however it should also be noted that adaptation decision-making is an iterative process and moving backwards or forwards to revisit a step or anticipate a future step may also be appropriate.

The early steps (1 & 2) focus on preparing the ground for an effective adaptation planning process and identifying what changes and impacts have the potential to give rise to wider and unacceptable sectoral impacts. Following on from this, step 3 involves prioritising ongoing and potential future climate impacts in the context of sectoral and policy objectives/targets. Step 4 builds on the scoping stage and examines those changes and impacts considered a sectoral priority; it involves a more thorough assessment of exposure, sensitivity and adaptive capacity (i.e. vulnerability). Steps 5 and 6 involve identifying a series of goals, objectives and actions, shifting the focus from potential impacts and vulnerabilities to identifying, prioritising and implementing adaptation actions.

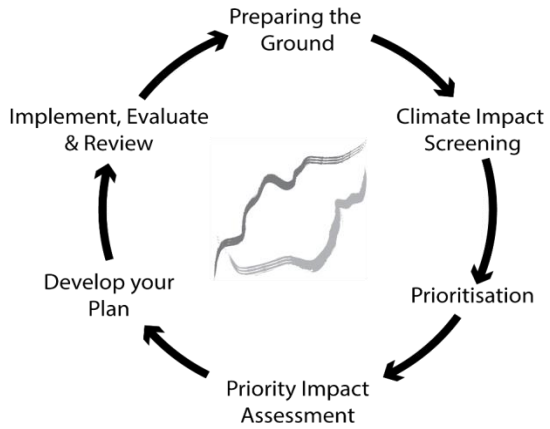

Figure 1 Schematic diagram of the adaptation planning process with the six key steps indicated.

Step 1 - Preparing the Ground

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

At the outset of the adaptation planning process, it is essential that a suitably qualified and experienced SAT is put in place to oversee and undertake the adaptation planning process. The SAT should consist of a Core Team (CT), that will co-ordinate and oversee the adaptation planning process, and a Planning Team (PT) which will ensure that a broad spectrum of relevant knowledge, know-how and technical expertise is considered in the development of the adaptation plan. It is important to note that as you progress through the adaptation planning process, the PT can be expanded to incorporate additional know-how, interests and skills where and when required. For example, findings and actions from your adaptation plan will have practical implications for a broad spectrum of stakeholders, these could include: Local Authorities, Emergency Services, Public Health services, etc. To ensure coherence of plans across sectors, the PT should consider, where possible, including representatives from other sectors that will be affected by your plan or actions arising from it or on whom actions are dependent.

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

Step 2 - Climate Impact Screening

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

As part of this screening, the current sectoral impact profile forms the focus and the baseline on which to assess the potential consequences of future climate changes. Once an understanding of sectoral vulnerability to and consequences of current and ongoing climate and weather-related impacts has been developed, an assessment of how projected changes in climate might exacerbate or ameliorate current levels of impacts is undertaken. The potential for projected changes to result in any new or emerging climate impacts and vulnerabilities is also assessed. At this stage of planning and when undertaking this

screening assessment, employing national level statements of observed and projected changes in climate are appropriate.

Step 3 - Prioritisation

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

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

Step 4 – Priority Impact Assessment

Once the potential climate changes and impacts that are likely to affect your sector have been identified and prioritised, a more detailed understanding of those climate changes and impacts considered a sectoral priority must be developed. The goal is to develop a more detailed understanding of vulnerability and identify a range of plausible climate change outcomes (impacts and consequences) based on multiple time horizons and on multiple emission levels that can provide the basis for the identification and assessment of adaptation options. This involves using more detailed climate information that provides an assessment of spatial and temporal variations in projected changes in key climate parameters and associated uncertainties.

Step 5 – Develop your Plan

Upon completion of the priority impact assessment, an understanding of vulnerabilities, the relative priorities and where and when the sector wants to direct its adaptation efforts will have been developed. The adaptation plan will consist of establishing goals, sequencing objectives, and identifying and prioritising actions to implement the plan. In addition, the plan will identify the risks, barriers and enablers associated with the implementation of identified adaptation options. It is likely that no single adaptation action will help you achieve all your objectives and that a variety of actions will be required. Adaptation actions can be

usefully classified into those that will address current sectoral impacts (e.g. those related to coastal inundation) and those that will build capacity to implement, monitor and evaluate the actions being introduced and those that address emerging and future climate-related impacts (e.g. temperature related impacts).

Step 6 - Implement, Evaluate and Review

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

Conclusion

The stepwise approach outlined above adopts a consistent approach to support Ireland's key sectors in planning for climate resilience and developing their respective adaptation plans (in accordance with both the requirements of the Climate Action and Low Carbon Development Act 2015 and the National Adaptation Framework). It adopts a proportionate and staged approach to the analysis of climate change impacts and sets out how sectoral responses can be framed in meeting these challenges.

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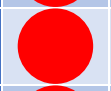
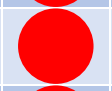
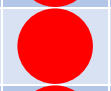
i.i Climate Change

Globally and for Ireland, climate is changing and the impacts of these changes are already being felt, and are expected to continue and intensify for many decades to come. Since the start of the industrial revolution, it is estimated that the levels of greenhouse gases (GHGs) we have already emitted to the atmosphere has warmed the world by an average of 0.8˚C. Each of the last three decades have been successively warmer at the Earth's surface than any preceding decade since 1850 and in the northern hemisphere, 1983-2012 was likely the warmest 30-year period of the last 1400 years (IPCC, 2013).

As a result of past and present emissions of GHGs from various sectors (see Table 1), including (but not limited to) carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), we are now committed to a substantial climate change until at least mid-century, regardless of ongoing efforts to limit GHG emissions. This is due to the inertia within the climate system, which takes centuries to adjust to changing concentrations of GHGs. The benefits of present and ongoing efforts to mitigate GHGs emissions will not be felt for centuries or more. Therefore, to prevent or minimise the adverse impacts of climate change, planned adaptation to climate change and the impacts of these changes is urgently required. This simply means anticipating and planning for the effects of climate change and taking appropriate actions to offset or minimise the adverse impacts of these changes whilst taking advantage of any opportunities that these changes and actions might bring.

Sector	CO_2	CH_4	N_20	% Contribution
Agriculture				33.1%
Energy				19.7%
Industry & Commercial				4.9%
Residential				10.1%
Transport				19.8%
Waste				1.6%

	GHG emitted from every activity within this sector
	GHG emitted from majority of activities within this sector
	GHG emitted from some of the activities within this sector
	GHG emitted from specific/individual activities within this sector

Table 1 Greenhouse gas emissions arising from different economic sectors. The dot size and colour indicates the number of activities within each sector that produce each GHG. % contribution to total national GHG emission are also shown. Abstracted from Ireland's National Greenhouse Gas Emission Projections (EPA 2017)

i.ii Climate Change in Ireland

Research has improved our understanding of projected climate change for Ireland and has provided critical insights into how climate change will impact us into the future. Observed changes in Ireland's climate are in line with global trends (Figure 2). Temperatures are increasing, sea levels are rising and seasonal patterns of storms and precipitation are changing (Dwyer, 2013).

Projections indicate that this trend will continue and intensify into the future; on average, Ireland's climate is projected to become warmer and drier, rates of sea level rise will increase and the frequency of extreme weather events are also expected to increase (Nolan, 2015; EEA, 2017). These changes and impacts will have a wide range of consequences for Ireland's social, environmental and economic sectors, some positive, others negative. Within individual sectors, a range of consequences both positive and negative may be present. For example, winters will become on average warmer and would likely benefit the agriculture sector due to less frost, but this benefit may be offset by heatwaves/drought during the summer months. Other changes and impacts may benefit some sectors positively while having negative impacts on other sectors. For example, projected changes in average and

extreme wind speed will likely have negative implications for the wind energy sector, while other sectors may benefit from reduced damage to infrastructure, houses and so forth. Finally, for other changes and impacts, it is difficult to conceive positive consequences for any of the sectors. For example, projected increases in sea level will put coastal infrastructure and communities at risk, while projected increases in the occurrence of extreme precipitation events will increase fluvial and pluvial flood risk further inland.

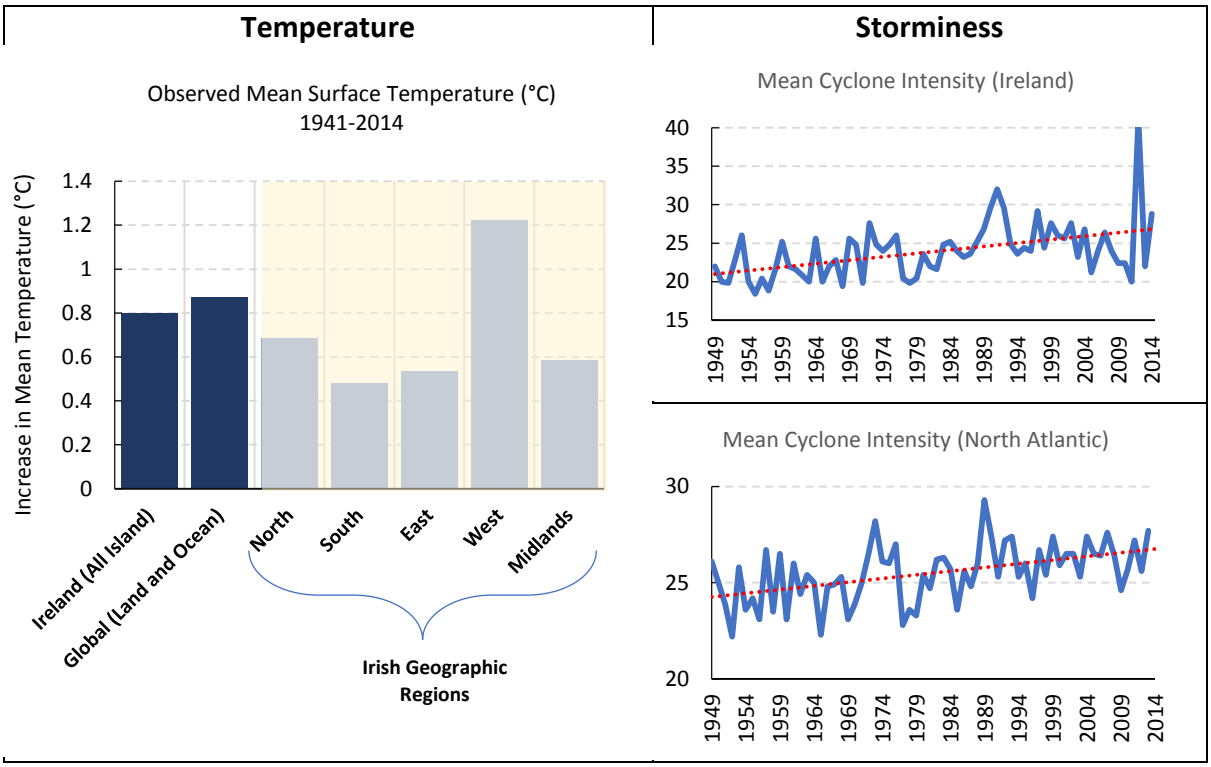


Figure 2 ***Left****: Temperature increase over the period 1941-2014 for Ireland and Globally (NOAA). The lighter blue bars further illustrate observed temperature change for different geographic regions in Ireland (Met Éireann).* ***Right:*** Cyclone intensity increase over the period 1949-2014 for Ireland (top) and North Atlantic Ocean (bottom) the red line illustrates the trend over time (Mathews *et al.,* 2014)

i.iii Climate Action

As at COP21 (Paris, 2015), climate change was recognised internationally as a global challenge with policy responses required in terms of both mitigating the causes of climate change and also in adapting to the now inevitable consequences of these changes (Figure 3). The first policy pursued in response to climate change, mitigation, aims to address the causes of climate change by reducing emissions of GHGs and enhancing carbon sinks (e.g. afforestation). Due to the inertia in the response of the climate system (e.g. temperature and precipitation changes and sea level rises), even if efforts to mitigate the causes of climate change are successful, many of the impacts are locked in for many decades to come. The second policy response, adaptation, aims to better prepare society to cope with, manage or

adjust to changing climatic conditions in order to offset the adverse impacts and take advantage of any opportunities that these changes might bring (IPCC, 2014).

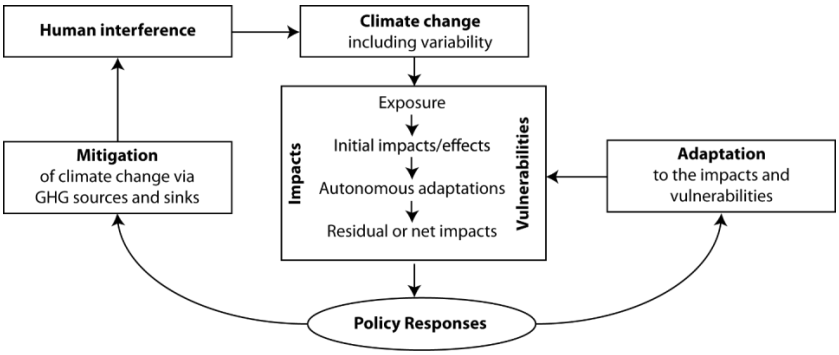


Figure 3 Schematic diagram of adaptation and mitigation responses.

Adaptation policy in the EU is a relatively new policy area. In 2013 the EU published the EU Adaptation Strategy (EC, COM(2013) 216), with the overall aim of contributing to a more climate resilient Europe. A key objective of the Strategy is to encourage all member states to adopt their own adaptation strategies, which would in turn prove the necessary policy context for the development of adaptation plans and the integration of adaptation measures into local and sectoral activities. The EU strategy is currently being evaluated with a view to assessing how successful the strategy has been. This evaluation is scheduled to conclude in 2018. To date, 25 European Environment Agency member countries have adopted a National Adaptation Strategy, including Ireland initially through the first and non-statutory National Climate Change Adaptation Framework (NCCAF) (DECLG, 2012), and 17 have developed a National Adaptation Plan (NAP) (EEA, 2014; EEA, 2017b). This initial NCCAF from 2012 aimed to ensure that adaptation actions to reduce the vulnerability to climate change impacts are taken across key economic sectors and also at the local level. The NCCAF called for the development and implementation of sectoral and local adaptation plans to form part of the national response to the impacts of climate change.

The Climate Action and Low Carbon Development Act 2015, Ireland's first dedicated climate change legislation, put the development of a National Adaptation Framework (NAF) and sectoral adaptation Plans on a statutory footing. Ireland's first NAF was published by the Minister for Communications, Climate Action and Environment (DCCAE) on 19 January 2018. The NAF provides for the preparation of statutory sectoral adaptation plans and specifies the national strategy for the application of adaptation measures (sectoral and local) to reduce the vulnerability of the state to the negative effects of climate change and to avail

of positive effects of climate change that may occur. Under the Act, the NAF will be reviewed at least once every 5 years.

The sectors and lead Government departments required to prepare sectoral adaptation plans under the NAF are as follows:

- Seafood - Department of Agriculture, Food and the Marine
- Agriculture - Department of Agriculture, Food and the Marine
- Forestry - Department of Agriculture, Food and the Marine
- Biodiversity - Department of Culture, Heritage and the Gaeltacht
- Cultural Heritage - Department of Culture, Heritage and the Gaeltacht
- Transport Infrastructure - Department of Transport, Tourism and Sport
- Electricity and Gas Networks - Department of Communications, Climate Action and Environment
- Communications Networks - Department of Communications, Climate Action and Environment
- Flood Risk Management - Office of Public Works
- Water Quality - Department of Housing, Planning and Local Government
- Water Services Infrastructure - Department of Housing, Planning and Local Government
- Health - Department of Health

i.iv Sectoral Adaptation

Ongoing and projected climate changes and impacts will pose a significant risk to Ireland's key economic sectors (Table 2). As a result, integrating adaptation into sectoral decision-making is a key aim of Ireland's Climate Action and Low Carbon Development Act 2015. This is because policy formulation at the sectoral level is considered a key entry point for adaptation, as it co-ordinates numerous, ongoing sectoral initiatives and informs the implementation of investments and activities. As a result, integration of adaptation at the sectoral level should aim to:

- Systematically add a climate lens as a criterion for the success of sectoral policy, strategies and projects;
- Consider the cross-sectoral nature of climate risks/impacts and of adaptation responses including potential synergies and conflicts;

- Develop adaptation goals, objectives and actions that blend the national top-down and bottom-up elements in a coherent and balanced way and design indicators to track performance of adaptation actions as part of the performance of the sector.

By doing so, the sector can (i) avoid excessively risky projects, (ii) incorporate appropriate climate-proofing measures for vulnerable projects selected for implementation, (iii) include activities that can actively contribute to reducing climate vulnerability in sectoral programmes and (iv) avoid potential conflicts and work in synergy with other sectors (OECD, 2009).

i.v Purpose of Sectoral Guidelines and Structure

In order to support key national sectors in planning for climate change adaptation, sectoral adaptation guidelines have been developed as part of the Environmental Protection Agency (EPA) and the DCCAE funded project 'A Climate Information Platform for Ireland' (ICIP). The guidelines have been developed by drawing on international best practice (e.g. EEA, 2013; Gray, 2015; Buth et al. 2017) and in close consultation with the Department of Transport, Tourism and Sport (DTTAS) and the Department of Agriculture, Food and the Marine (DAFM). The guidelines aim to ensure that a coherent and consistent approach to adaptation planning is adopted at national and sectoral scales and draws on existing sources of climate and adaptation information (e.g. Climate Ireland).

The guidelines are structured around 6 steps: 1) Preparing the Ground; 2) Climate Impact Screening; 3) Prioritisation; 4) Priority Impact Assessment; 5) Develop your Plan; 6) Implement, Evaluate and Review. Figure 4 shows these steps in sequence, but also that adaptation decision-making is an iterative and continuous learning process and that moving backwards or forwards to revisit a step or anticipate a future step based on considerations within a current step may also be required.

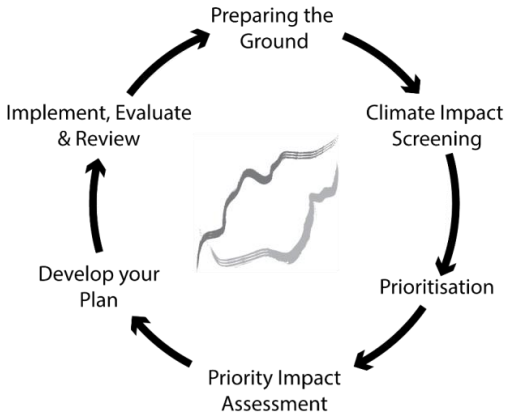


Figure 4 Schematic diagram of the adaptation planning process with the six key steps indicated.

The emphasis of the guidelines is on a staged and proportionate approach to adaptation planning. The early steps (1 & 2) focus on preparing the ground for an effective adaptation planning process and identifying what changes and impacts have the potential to give rise to wider and unacceptable sectoral impacts. Following on from this, step 3 involves prioritising ongoing and potential future climate impacts in the context of sectoral and policy objectives/targets. Step 4 builds on the scoping stage and examines those changes and impacts considered a sectoral priority, it involves a more thorough assessment of exposure, sensitivity and adaptive capacity (i.e. vulnerability). Steps 5 and 6 involves identifying a series of goals, objectives and actions, shifting the focus from potential impacts and vulnerabilities to identifying, prioritising and implementing adaptation actions.

Summary of Observed and Projected Climate Changes and Impacts for Ireland to 2050 and beyond			
Parameter	Observed	Projected	Examples of Impacts
 **Temperature**	• Average temperatures have increased by 0.8°C over the period 1900-2011; • The number of warm days (over 20°C) has increased while the number of cold days (below 0°C) has decreased (Dwyer, 2012).	• Projections indicate an increase in average temperatures across all seasons (0.9 – 1.7°C) (Nolan, 2015); • The number of warm days is expected to increase and heat waves are expected to occur more frequently (Nolan, 2015).	• Incidences of cold stress are likely to decrease while incidences of heat stress will increase. • The duration of the growing season will increase, occurring earlier and extending farther.
 **Precipitation**	• When compared with the period 1961-1990, levels of annual average rainfall have increased (5%) for the period 1981-2010. • The largest increases are observed over the west of the country (Dwyer, 2012).	• Significant reductions are expected in average levels of annual, spring and summer rainfall (Nolan, 2015). • Projections indicate a substantial increase in the frequency of heavy precipitation events (approx. 20%), particularly during winter (Nolan, 2015).	• The increased occurrence of dry spells will result in increased pressure on water supply and those dependent activities. • An increase in the frequency of extreme precipitation events will result in increased fluvial and pluvial flood risk.
 **Wind Speed & Storms**	• No long-term change in average wind speed or direction can be determined with confidence (Dwyer, 2012). • The number and intensity of storms in the North Atlantic has increased in recent decades (IPCC, 2014); • The number of these storms tracking over Ireland has remained variable (Dwyer, 2012).	• Projections indicate an overall decrease in wind speed and an increase in extreme wind speeds, particularly during winter (Nolan, 2015). • The number of very intense storms is projected to increase over the North Atlantic region. Projections suggest that the winter track of these storms may extend further south and over Ireland more often (Nolan, 2015).	• Increases in extreme wind speeds may impact on wind turbines and the continuity of power supply. • Infrastructure will be at risk due to the increased occurrence of intense storms (e.g. winter 2013/2014).
 **Sea Level & Sea Surface Temperature**	• Sea levels are rising at approx. 3.5 cm per decade in the coastal areas surrounding Ireland with the greatest increases recorded for the Irish Sea (Dwyer, 2012). • Sea surface temperatures have increased by 0.7°C since 1850, with an unprecedented rate of warming since 1994 (0.6°C per decade) (Dwyer, 2012).	• Sea levels will continue to rise for all coastal areas, by up to 0.8 m by 2100. The south of Ireland will likely feel the impacts of these rises first (EEA, 2014). • Sea surface temperatures are projected to continue warming for the coming decade. For the Irish Sea, projections indicate a warming of 1.9°C by the end of the century (Olbert et al., 2012).	• Significant increase in areas at risk of coastal inundation and erosion. • Increased risk to coastal aquifers and water supply. • Change in distribution of fish species. • Implications for fisheries and aquaculture industries.

Table 2 Summary of Observed and Projected Climate Changes for Ireland. Examples of potential impacts are also included.

1. Preparing the Ground (Step 1)

At the outset of the adaptation planning process, it is important to ensure that the foundations for designing and delivering an effective adaptation planning process are established. To do this, a number of key elements need to be put in place and these include:

- **A Sectoral Adaptation Team** - To ensure that the relevant knowledge, know-how and skills are brought to bear to the planning process, it is essential that a suitably qualified and experienced Sectoral Adaptation Team (SAT) is put in place to oversee and undertake the adaptation planning process. It is also important to identify and engage with relevant stakeholders and identify their roles;
- **A Shared Understanding** - To develop understanding, engagement and collaboration amongst the SAT and the sector more generally, it is important to develop a shared understanding of climate change, impacts and adaptation;
- **Adequate Resources** - At this stage of plan preparation, it is important to recognise that adaptation planning will have resource implications for your sector and planning efforts will require human, technical and financial resources. The level of resources that can be brought to bear will determine the scope and limitations of your plan.

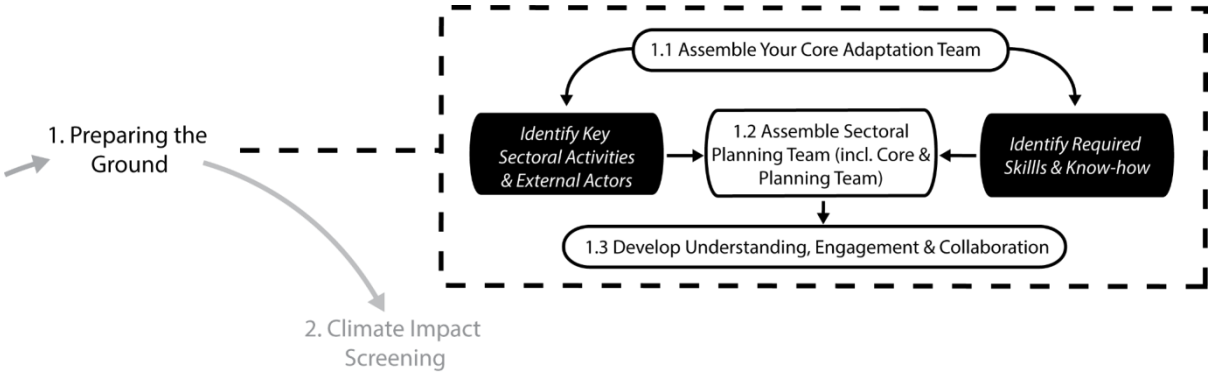


Figure 5 Schematic diagram illustrating the key tasks associated with Step 1 (Preparing the Ground)

1.1 Assemble Your Sectoral Adaptation Planning Team

The SAT should consist of a Core Team (CT), that will co-ordinate and oversee the adaptation planning process, and a Planning Team (PT) which will ensure that a broad spectrum of relevant knowledge, know-how and technical expertise is considered in the development of the adaptation plan.

1.1.1 Assemble your Core Team

The **Core Team (CT)** will be responsible for overseeing, coordinating and advocating climate change adaptation from planning through to implementation and beyond. Key responsibilities for the CT include:

- Identifying stakeholders and assembling the PT;
- Developing a plan to engage and involve stakeholders, including identifying their specific roles and supporting capacity building;
- Communicating goals and parameters;
- Creating working groups and designating leaders;
- Establishing roles and responsibilities and defining expectations;
- Setting a schedule and managing the process.

1.1.2 Assemble your Planning Team

Once the CT has been assembled, its first task will be to assemble a wider PT. This is because planning for climate change adaptation relies on a wide variety of partners representing key sectoral interests and activities. These partners will provide technical know-how and information, apply the science to decipher sensitivities within your sector and will come from agencies and organisations that have investment or management responsibilities. As you progress through the adaptation planning process, the PT can be expanded to incorporate additional know-how, interests and skills where and when required. The development of the adaptation plan will have resource implications (human, technical and financial), including a member of senior management or a representative of senior management in your SAT is necessary.

Sectoral Activities

Breaking your sector into the constituent activities and sub sectors will help you in the process of identifying the best representatives for the PT. In addition, this breakdown of sectoral activities will make the overall process of adaptation planning more manageable. Examples of sectoral breakdowns for the transport and agriculture sectors are shown in Figure 6.

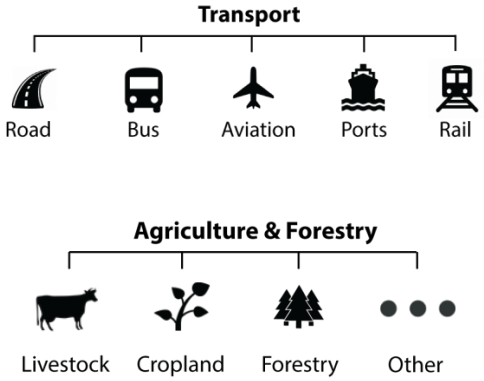


Figure 6 Breakdown of sectoral activities for Transport (Top) and Agriculture (bottom). Sectoral activities for transport were identified as Road, Bus, Aviation, Ports and Rail (including light rail). For Agriculture, sectoral activities were identified as Livestock, Cropland, Forestry and Other.

Essential Skills and Know-How

Adaptation planning will require technical data and know-how and this should ideally be secured at the team building stage. The composition of the PT is described above, in addition to the scientific knowledge base assembled in the PT, essential skills include basic skills in Excel (or equivalent), Geographic Information Systems (GIS) and may also include more sophisticated modelling techniques and programmes. If you do not have access to the technical expertise or the necessary computing capacity, it may be necessary to contract in external expertise from the private or third level education sectors.

External Stakeholders

The development of your strategy will have implications for others working outside of your sector. For example, findings and actions from your adaptation plan will have practical implications for other Sectors, Local Authorities, Emergency Services and Public Health services. As a result, it is important to identify and engage with external stakeholders who may be affected as a result of dependencies or interdependencies of actions arising from your (or their) plan. In addition, there may be external stakeholders who can serve the planning team in a supporting role by providing resources, expertise, and experience. These might include those who have experience in adaptation planning or those with specific expertise (e.g. Universities; External Agencies).

Involving Stakeholders in the Transport Sector

When developing your plan, it is important to remember that the makeup of the team will influence the scope of the plan. In developing the draft Adaptation Plan for the Transport sector under the NCCAF, a wide variety of internal and external stakeholders were consulted to ensure that all relevant information and know-how were included in the development of the plan.

Internal	External	
• Roads Division • Airports Division • Ports Division • Public Transport Division • Emergency Planning	• Transport Infrastructure Ireland; • Iarnród Éireann; • Dublin Bus; • Bus Éireann; • Irish Aviation Authority; • Commission for Aviation Regulation; • Dublin Airport Authority; • Shannon Airport Authority; • IBEC/Irish Ports Association; • Dublin Port Company;	• Port of Cork; • Shannon Foynes Port; • Port of Waterford; • Drogheda Port Company; • Dún Laoghaire Port Company; • Port of Galway; • South Dublin County Council; • Department of Communications, Climate Action and the Environment.

Box 1 Details of those organisations that participated in the development of the draft adaptation strategy for transport.

1.2 Develop Understanding, Engagement and Collaboration

Adaptation is still a new area of planning for many sectors and understanding of climate change, impacts and adaptation is central to a successful adaptation planning process. Efforts to improve understanding will be ongoing throughout the process and it is important to remember that adaptation planning as a process will involve an element of *learning-by-doing* where each step and iteration of the process provide opportunities and new insights. You are encouraged to bring stakeholders into the process early, to promote interest around adaptation and, to secure their support. At the outset of the planning process, you should consider holding a kick-off meeting to:

- Create a common understanding of climate change and of an overall vision/goal for adaptation;
- Communicate process goals and parameters (e.g. scope and planning timeframe);
- Communicate a common understanding of the adaptation planning process and set a schedule.

As the plan takes shape, you are encouraged to ask for stakeholder input within all steps of the planning process. For example, as part of Climate Impact Screening (Step 2), local knowledge of past events, exposures and opinions can be critical in designing options to

protect against adverse impacts. There are many benefits to including stakeholders in the planning process and these include:

- Developing a better understanding of vulnerabilities and risk;
- Identification of potential synergies and conflicts associated with proposed adaptation measures;
- Securing buy-in for the adaptation plan, including in implementation, monitoring and evaluation; and
- Develop an informed stakeholder community to support subsequent iterations of the planning process.

Developing a Shared Understanding of Climate Change and Adaptation

There are many ways of developing a shared understanding of climate change and adaptation for your sector, key elements will include:

- Describing changes that have already been observed at global and national levels;
- Describing the implications (vulnerabilities) associated with current climate variability and changes in climate and actions that have already been implemented in response;
- Describing climate changes that are expected at national levels;
- Describing the potential impacts and consequence of these for sectoral activities;
- Outlining the need to identify and assess proposed adaptation measures;
- Conveying the need for action but balance the challenge with some optimism by highlighting the opportunities presented by effective adaptation;
- Acknowledging that questions remain.

Climate Ireland provides a wide range of information to help you and your team better understand climate change, adaptation and impacts.

- Introduction to Climate Change and Adaptation
- The Status of Ireland's Climate Tool
- Essential Climate Information
- Sectoral Information Tool

Box 2 Developing a shared understanding of climate change and adaptation

Before Moving On

Having completed the first step in the preparation of your sectoral adaptation strategy, a number of key building blocks should now be in place:

- ✓ A Sectoral Adaptation Team has been established which consists of both Core Team and a wider Planning Team;

- ✓ A shared understanding of climate change, impacts and adaptation has been developed.

2. Climate Impact Screening (Step 2)

Ireland's climate is changing and the impacts of these changes are already being felt. In order to plan for sectoral consequences of these changes and impacts, it is essential that a preliminary assessment (screening) of current and potential future sectoral vulnerability (including those which result from cross-sector dependencies and interdependencies) to these changes is undertaken. The purpose of this exercise is to allow the PT to develop a broad understanding of sectoral vulnerability to climate change, the sectoral consequences of these, and to collect all the relevant preliminary information to allow for the prioritisation of the most urgent climate changes and impacts for further and more detailed analysis.

The first step of the preliminary screening is to focus on the current situation and generate a baseline on which to assess potential future sectoral vulnerabilities to climate change and the consequences of these (Figure 7). Following from this, the focus of the assessment shifts to the future and you will assess how projected changes in climate might exacerbate or ameliorate current levels of vulnerability and identify whether or not projected changes will result in any new or emerging climate vulnerabilities.

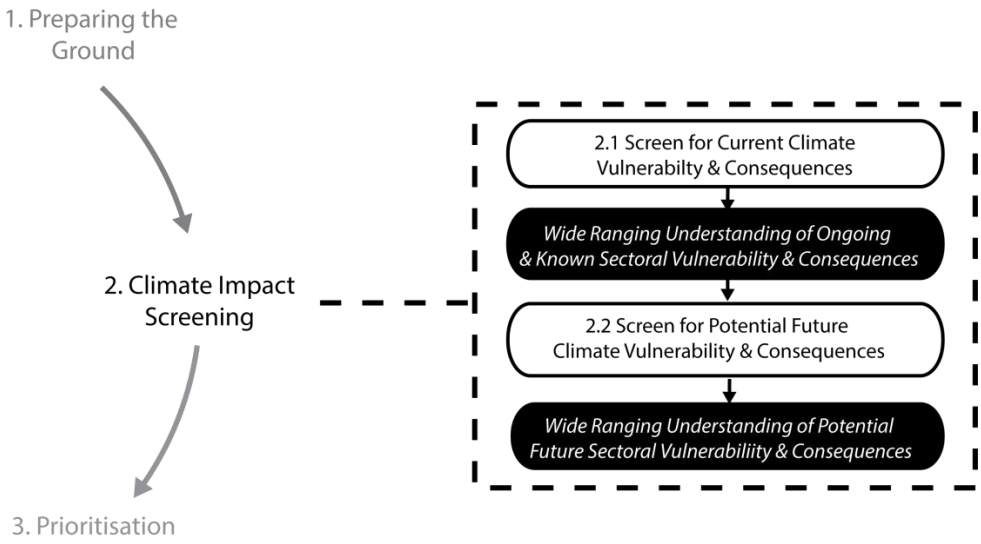


Figure 7 Schematic diagram illustrating the tasks associated with Step 2.

The Impact Chain Approach

When undertaking this assessment, an impact-chain approach will be adopted. Impact chains provide the basic framework for assessing vulnerability to climate change and supports understanding, systemisation and prioritisation of which factors influence the level

of vulnerability (Buth et al. 2017). In addition, impact chains serve as important tools for communication and can help stakeholders in coming to agreement on what needs to be assessed and which climate change and impacts play a role.

Based on Buth et al. (2017) and as illustrated in Figure 8, impact chains are developed around a number of key concepts and these include: climate stimuli, sensitivity, exposure, adaptive capacity, impacts (biophysical and socio-economic) and sectoral consequences, as outlined below:

- **Climate Stimuli** are described by changes in climate variability (away from the mean) (e.g. periods of increased temperatures) and in the frequency and magnitude of extremes that are relevant for a climate impact;

- **Sensitivity** (Susceptibility or fragility) describes the extent to which a system (economic sector/population group) reacts to changes in climate stimuli. The effect may be direct (e.g. change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damages caused by an increase in coastal flooding due to sea level rise);

- **Exposure** refers to the presence of a system/infrastructure/population potentially impacted upon by the climatic stimuli in the area of investigation;

- **Adaptive Capacity** refers to the possibility for a system to adapt to climate change through measures to reduce adverse impacts or exploit new opportunities. There are a wide range of factors which contribute to or reflect adaptive capacity and these include resource availability (human, technological and financial), information and skills, and institutional capacity;

- **Impacts** refer to the observed or potential impact (biophysical and socio-economic) of the climate stimuli on the system taking into account sensitivity, exposure and adaptive capacity;

- **Sectoral Consequence** results from a climate impact on a system/infrastructure/population and accounting for adaptive capacity.

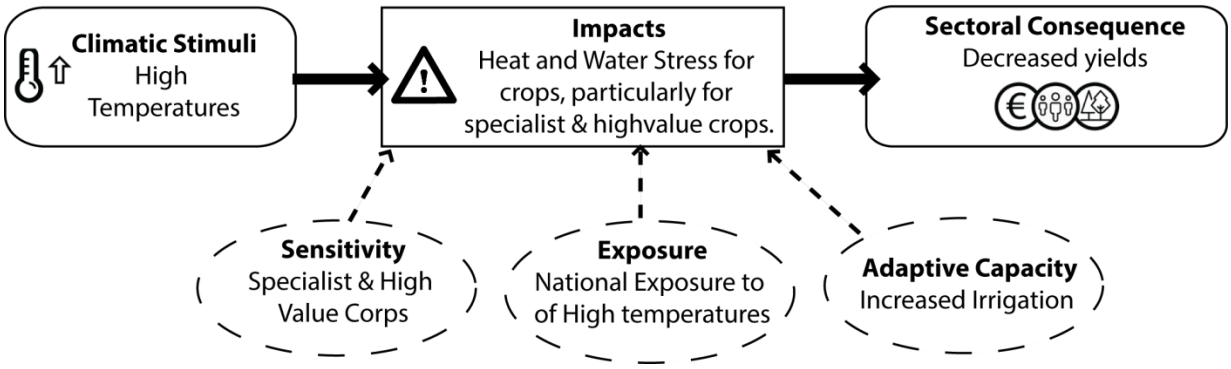


Figure 8 Schematic diagram of a climate impact chain. Increasing temperature will result in a prolonged exposure of sensitive crops (e.g. specialist and high value crops) to higher temperatures and results in heat and water stress for these crops and decreased yields (sectoral consequences). It is important to note that when employing impact chains, it is possible to start the analysis by examining the sectoral consequence and then work in reverse through the impact chain.

Scope of the Assessment

In undertaking this impact screening exercise, it is recommended that you develop simple impact chains for all climate and weather-related impacts affecting your sector. These should be based on existing knowledge (including literature), regardless of whether the impacts can be represented with models or quantitative indicators. As you move, however, through the process and to more detailed analysis, PT members should collect relevant maps and datasets to better understand where vulnerability to climate impacts is greatest and for further and more detailed analysis.

2.1 Screening for Current Climate Impacts

"the first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability" (IPCC, 2014)

In screening for sectoral vulnerability and consequences of current climate impacts the SAT will:

- Identify past weather events and periods of climatic variability that have been deemed to have had consequences for your sector and identify the relevant climatic stimuli;
- With reference to the relevant weather event, period of climate variability or change provide an overview of the impact (accounting for exposure, sensitivity and adaptive capacity) and outline the sectoral consequences of these changes;

- Provide an estimate of the magnitude of the impact and in terms of social, economic and environmental considerations.

In undertaking these tasks, you will require two specific types of information:

- **National Scale Climatological and Meteorological Information:** National level information on observed trends in key climate parameters and the meteorological characteristics of recent extreme weather events is required to support the identification of ongoing and climate and weather-related impacts that have had consequences for your sector.

  National level information on gradual changes in Ireland's Climate can be accessed through Climate Ireland's Status of Ireland's Climate Tool;

  Meteorological information on extreme weather events and periods of climate variability can be accessed through Met Éireann's Extreme Weather Event Database.

- **Sector specific data:** To support the identification of impacts and consequences of ongoing climate change and extreme weather events, existing information (e.g. in-house reports, information on disruption/failures, production and operational data) and stakeholder input should be captured and employed. Any information relating to critical thresholds or sensitivities of sectoral activities to climate or weather-related impacts should be noted here.

By following this process, you will have performed a preliminary assessment of sectoral vulnerability to past weather events, periods of climate variability and change and produced a list of the full known range of current climate and weather-related consequences for sectoral activities. This should also include those as a result of critical cross-sector dependencies and interdependencies.

2.1.1 Identify Past Weather Events, Periods of Climate Variability and Change that have Impacted upon Sectoral Activities.

Weather events, periods of climate variability and change that have impacted your sector in the past will form the baseline for assessment of potential future sectoral vulnerability to climate change and the consequences of these for the sector. When considering past events and periods of climate variability, you should include the full range of past weather events and periods of climate variability that are deemed to have affected your sector, but also

consider recent changes in climate and their implications for climate variability and extremes.

For example, a popular climatological baseline period is a 30-year “normal” period as defined by the World Meteorological Organisation (WMO). In the context of developing adaptation strategies for Ireland, however, recent decades are not fully representative of the long-term drought climatology and there is a danger that plans benchmarked against the last 30 years may underestimate potential climate impacts (Noone et al. 2017). As a result, when identifying past weather events, periods of climate variability and change that have affected your sector, you should consider historical as well as recent events.

The SAT should identify past weather events and periods of climate variability that have been of sectoral significance (Figure 9). For each of the identified weather events or periods of climate variability, the relevant climatic stimuli and the specific consequences for the sector should then be identified. Past weather events may include periods of extreme rainfall, storms, heatwaves or dry spells. Periods of climate variability might include periods of high surface air temperatures and changes in spatial and temporal patterns of precipitation.

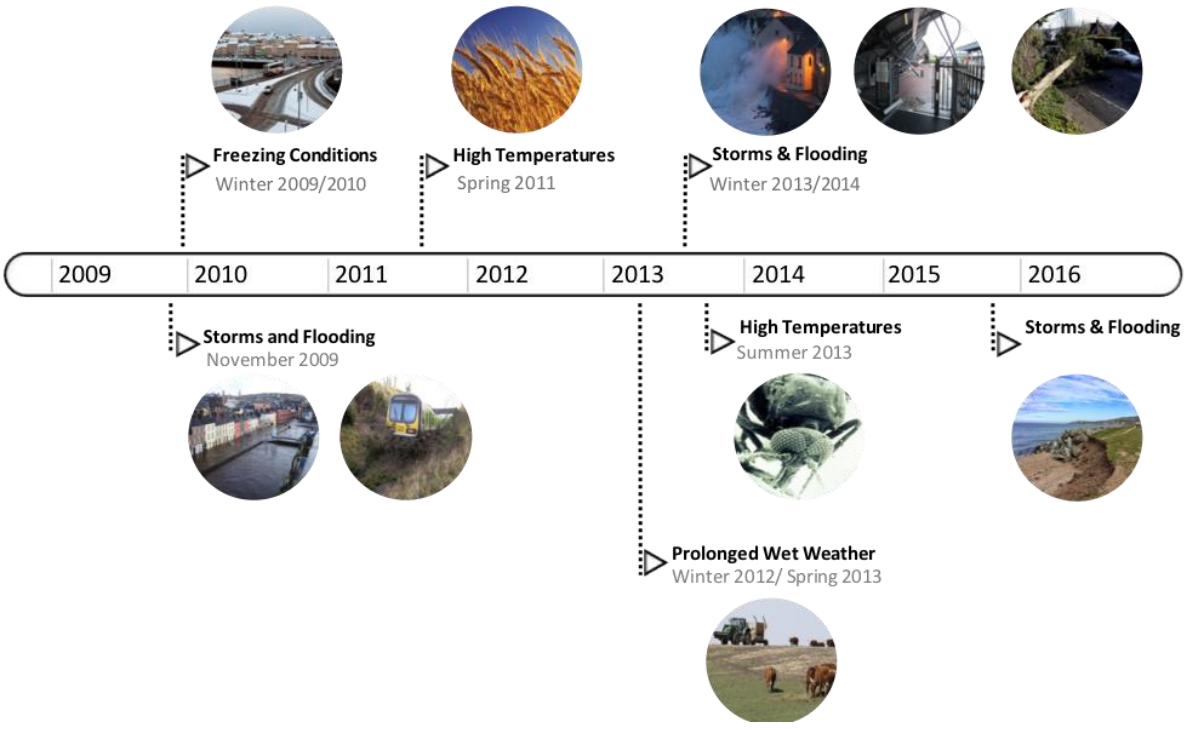
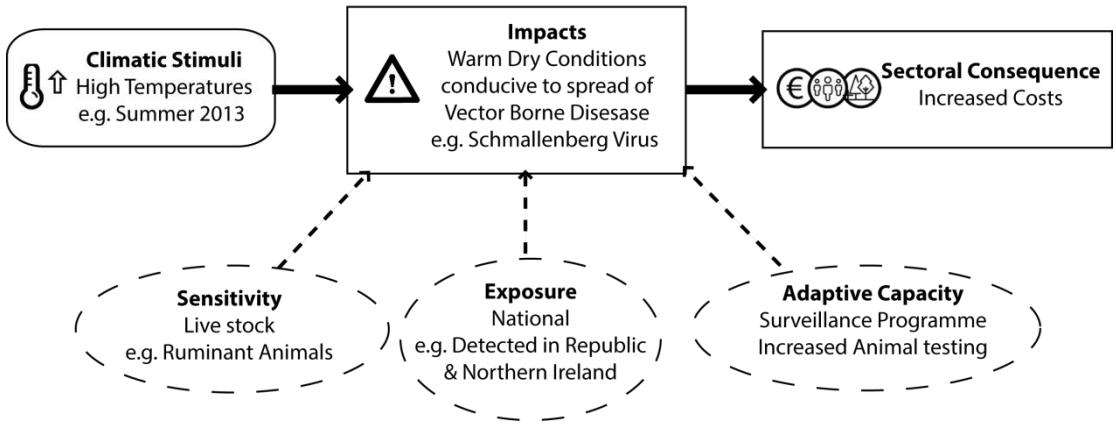


Figure 9 An example of climatic stimuli and relevant events identified by the DTTAS and DAFM SATs as having detrimental sectoral consequences

2.1.2 Provide an Overview of Impacts and Sectoral Consequences

Once the range of weather events and periods of climate variability that have affected your sector have been identified, the next task is to capture information on the impacts (biophysical and socio-economic) and consequences of these for your sector. As illustrated in Box 3, and adopting an impact chain approach, this involves providing an overview of the impact and sectoral consequence on the basis of the sensitivity, exposure and adaptive capacity. For sensitivity, identify the elements (e.g. systems/infrastructure/populations) that were specifically impacted upon and for exposure, indicate whether exposure to the event occurred on national, regional, local or site-specific basis. For adaptive capacity, identify any measures in place to offset adverse impacts (e.g. emergency response measures that offset impacts), moderate potential damages (e.g. business continuity plans) or take advantage of opportunities (e.g. adaptation strategy). A number of other factors contribute to adaptive capacity including leadership and the experience of the sector in responding to a particularly impact.

Vector Borne Disease (Increased/High Temperatures)



Climatic Stimuli: High Temperatures / Warm Dry Conditions.

Biophysical Impact: Increase in vector borne virus: Schmallenberg virus is primarily spread by the *Culicoides midge* and was first detected in Ireland in October 2012. Once detected a rapid spread of Schmallenberg was expected, the warm dry conditions of summer 2013 were conducive to the virus spreading. However, this did not occur, probably due to the low temperatures of winter 2012 which may have reduced the standing population of *Culicoides midge* in advance of 2013.

Sectoral Consequence: Increased costs resulting from the requirement for increased levels of surveillance and animal testing.

Box 3 An example of an impact chain for vector borne virus developed for the Agriculture sector.

2.1.3 Identify the Magnitude of Impact

Adaptation actions that are designed to offset adverse climate impacts will inevitably involve making trade-offs concerning the use of scarce resources. As such, it is useful to provide an assessment of the magnitude of ongoing climate and weather-related impacts to allow for:

- Comparison of impacts associated with past weather events and periods of climate variability;
- Provide a base-line of weather and climate related impacts, the consequences of these and for the assessment of how levels of impact and subsequent sectoral consequence might change as a result of projected climate change.

Quantifying the magnitude of impact is not an easy task and there is no single measure of impact that can be used across themes and for different sectors. Therefore, any categorisation is imperfect but a general classification can still be useful. As detailed in Table 3, the impact metrics employed in this guide are based on those used in the first UK Climate Change Risk Assessment (2012) and vary in character – some impacts are quantifiable while others are based on stakeholder judgement or a narrative based on the literature. To allow comparison of the different impacts, they have been categorised according to order of magnitude/approximate size of impact and with reference to economic, environmental and social impacts.

Class	Economic	Environmental	Social
High	• Major and recurrent damage to property and infrastructure • Major consequences on regional and national economy • Major cross sector consequences • Major disruption or loss of national or international transport links • €100 million for a single event/year	• Major loss or decline in long-term quality of valued species/habitats or landscape • Major or long-term decline in status condition of sites of international or national significance • Widespread failure of ecosystem function or services • Widespread decline in land/water/air quality • Major cross-sector consequences • 5000 ha lost/gained • 10000km of river water quality affected	• Potential for many fatalities or serious harm • Loss or major disruption to utilities • Major consequences on vulnerable groups • Increase in national health burden • Large reduction in community services • Major damage or loss of cultural assets/high symbolic value • Major role for emergency services • Major impacts on personal security • Thousands affected • 100's harmed • 10's fatalities
Medium	• Widespread damage to property or infrastructure • Influence on regional economy • Consequences on operations and service provision initiating contingency plans • Major disruption of national transport links • Moderate cross-sector consequences • Moderate loss/gain of employment opportunities • €10 million for a single event or year	• Important/medium-term consequences on species/habitat/landscape • Medium-term or moderate loss of quality/status of sites of national importance • Regional declines in land/water/air quality • Medium-term or regional loss/decline in ecosystem services • Moderate cross sector consequences • 500 ha lost/gained • 1000 km of river quality affected	• Significant numbers affected • Minor disruption to utilities • Increased inequality, e.g. through raising costs of service provision • Consequences on health burden • Moderate reduction in community services • Moderate increased role for emergency services • Minor impacts on personal security • Thousands affected • 100's harmed • 10's fatalities
Low	• Minor or very local consequences • No consequences on national or regional economy • Localised disruption of transport • €1 million per event/year	• Short-term/reversible effects on species/habitat/landscape or ecosystem services • Localised decline in land/water/air quality • Short-term loss/minor decline in quality/status of designated sites • 50 ha of valued habitats damaged/improved • 100km river water quality affected	• Small number affected • Small reduction in community services • Within coping range • 100's affected

Table 3 Impact Metrics (adapted from the UK CCRA, 2012)

2.2 Screening for Future Climate Impacts and Consequences

Now that you have assessed the known impacts and consequences of past weather events and periods of climate variability for your sector, the potential future impacts and sectoral consequences of projected changes in Ireland's climate can be assessed and should be carried out in consultation with your PT. As illustrated in Figure 10 this will involve assessing how projected changes in climate might affect current levels of impact (increase/decrease), the sectoral consequences of these changes, and whether projected climate change will result in any other emerging impacts with consequences for sectoral activities.

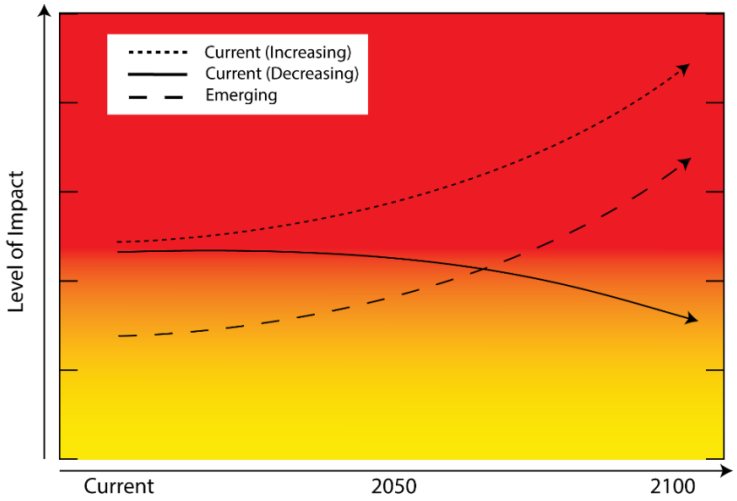


Figure 10 Schematic diagram illustrating the range of impact pathways employed to define how current levels of impacts might change into the future and whether there are any emerging impacts that should be considered.

The approach to assessment will employ the outputs from your scoping for current climate impacts. In undertaking this assessment, you will employ:

- **National scale information on the projected changes in Irelands climate:** To help determine whether currently observed impacts are likely to continue or change under projected climate conditions, national level statements of projected climate changes will be employed. This information will also be used to identify any new/ emerging impacts resulting from projected changes in climate.

  National level information on projected changes in Ireland's Climate can be accessed through Climate Ireland's Essential Climate Information Tool.

  National level information on projected changes in the biophysical impacts of climate change can be accessed through Climate Ireland's Climate Hazard Scoping Tool.

- **Sector specific data:** To support the identification of impacts and potential sectoral consequences, existing information (e.g. in-house reports, information on

disruption/failures, production and operational data, thresholds and sensitivities of sectoral activities to climate and weather-related impacts) and stakeholder input will be employed. On an international basis, there is a wide range of information on potential sectoral impacts and consequences of climate change, this information should be consulted when assessing got the potential future impacts and consequences of climate change. In undertaking this process, existing stressors and assets potentially exposed to future impacts should be identified. As you move through the process and to more detailed analysis, PT members should collect and bring to inform the assessment relevant maps and datasets to better understand where vulnerability to climate impacts is greatest and in order to identify priorities (Step 3). For some impacts, there may be little existing information to support impact and vulnerability assessment. This should be noted as part of screening and may form a priority for investigation or research.

Climate Ireland's Sectoral Information tool provides an overview of key climate changes for Ireland and the potential sectoral consequences of these.

2.2.1 Identify potential Future Climate Changes of Sectoral Significance

Weather events and periods of climate variability that have impacted your sector in the past are likely to continue to do so into the future. As a result, when identifying potential future climate change and impacts of sectoral significance, it is useful to start with those that are already impacting upon your sector (Box 4). For those weather events and periods of climate variability that are already impacting upon your sector, the PT should:

- Examine and document available national level information on projected changes in climate to assess how key climatic stimuli might change into the future;
- Assess how these changes might increase or decrease existing climate impacts and on the basis of changes in exposure and sensitivity;
- Identify how these changes might affect levels of sectoral consequences. When undertaking this assessment, it is recommended that you integrate adaptive capacity according to the status quo, i.e. its current condition. This is to allow you identify additional measures to enhance adaptive capacity as part of adaptation planning (Step 5).

Although some activities may not currently be impacted upon by weather events and periods of climate variability, they may be sensitive to projected changes in climate and may experience impacts in the future. As a result, you should also consider the full range of

projected climate changes, the impacts of these and consider the sensitivity of activities within your sector and whether any thresholds might be exceeded. In addition, it is important to identify whether these changes might result in any new or emerging climate impacts for the sector. If there is evidence of sensitivity to particular changes, these will also need to be considered as part of your adaptation planning process. Box 5 illustrates how without additional adaptive measures impacts associated with extreme heat are projected to increase for the transport sector, for example, through increases in the frequency of rail buckling.

For new or emerging climate impacts, provide a list of the potential sectoral impacts and consequences. Impacts should be assessed in relation to potential changes in levels of exposure and sensitivity to a climate impact and the potential sectoral consequences of these changes identified.

2.2.2 Assess the magnitude of Potential Future Sectoral Impacts

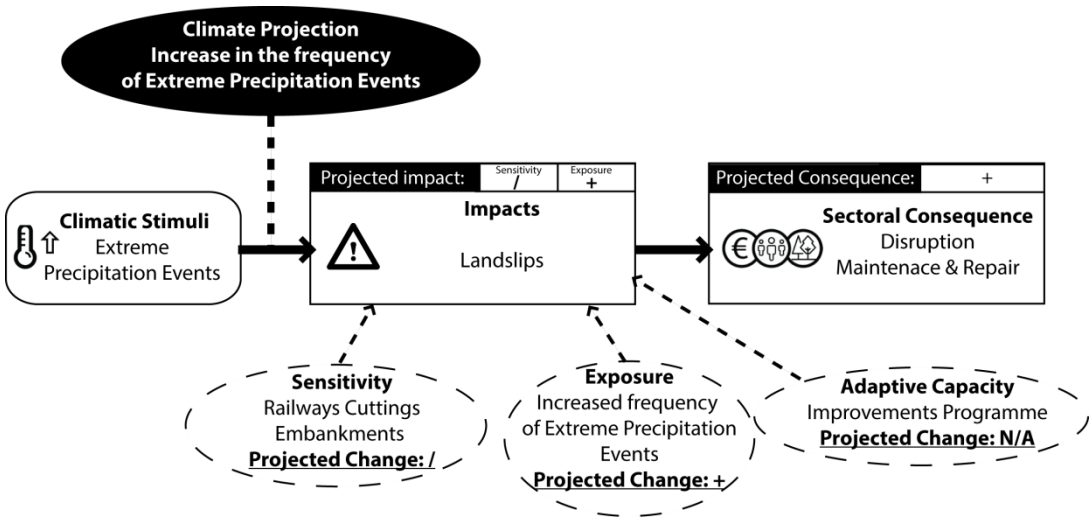
Now that you have identified how the impacts of extreme weather and periods of climate variability might change into the future, it is useful to provide an indication of the magnitude of impacts associated with these changes. This can be achieved in the same way as you identified the magnitude of current climate impacts (Step 2.1.3).

Before Moving On

Having completed the Climate Impact Screening, you should have developed a broad understanding of:

- ✓ The sectoral impacts and consequences of extreme weather events and periods of climate variability;
- ✓ The potential future sectoral impacts and consequences of projected changes in climate change, including those from extreme weather events and periods of climate variability.

Landslip Risk for the Irish Rail Network (Extreme Precipitation)



Impact: Landslips on the Irish Rail Network resulting from extreme precipitation events.

Projected Change in Relevant Climate Stimuli: An increase in occurrence of extreme precipitation events is expected.

Projected Impact: The increased occurrence of landslides associated with projected changes in extreme precipitation can be expected and applies not only to railways and roads situated on cuttings and hill sides but also railways and roads on embankments designed to provide support for road and rail lines.

Projected Sectoral Consequence: Increase in levels of disruption, and maintenance and repair costs.

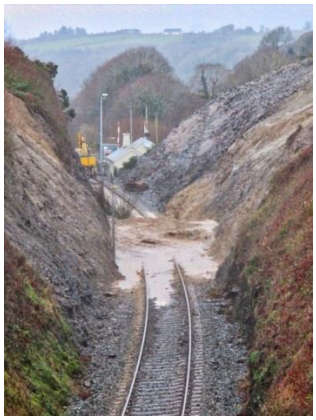
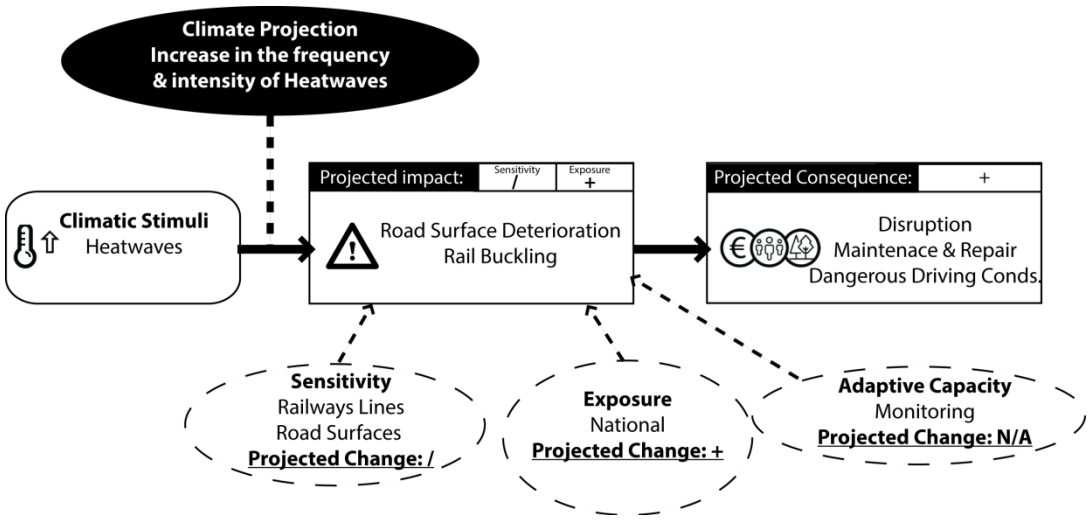


Plate 1 Landslide observed between Farranfore and Killarney on December 29th, 2015 (photo credit: Iarnróid Éireann)

Box 4 An example of an impact chain for landslip developed for the Transport sector.

Road Deterioration and Rail Buckling (Extreme Temperatures)



Impact: Deterioration of railway lines (buckling) and road surfaces (rutting) due to high temperatures.

Projected Change in Relevant Climate Stimuli: An increase in occurrence of heatwaves.

Projected Impact: The increased occurrence of extreme temperatures has the potential to increase adverse impacts on railways and roads.

Projected Sectoral Consequence: Increase in levels of disruption, monitoring, maintenance and repair costs.

Plate 1 Example of a Rail Buckling Incident 2015 (photo credit: Iarnród Éireann).

Box 5 An example of an impact chain for road deterioration and rail buckling developed for the Transport sector.

3. Prioritisation (Step 3)

Through the Climate Impact Screening (Step 2), a good understanding of sectoral vulnerability to climate change and the consequences of these will have been developed. In this step, climate impacts and vulnerabilities will be prioritised for further and more detailed analysis. This is a critical step as this prioritisation will be used to focus your adaptation efforts and to set the goals and actions that your sector will take to meet them. It is important, however, to remember that for those impacts and vulnerabilities not currently considered a priority, a watching brief should be maintained.

3.1 Prioritising Climate Changes and Impacts for further and more Detailed Analysis

In prioritising climate impacts, all stakeholders should be consulted, the results of the Climate Impact Screening (Step 2) should be presented and discussed and any limitations clearly noted and rationalised. At this stage of assessment, it is also important to recognise sectoral dependencies and interdependencies, an impact may not be a priority for a specific sector but addressing the impact may be a priority for another sector or local authority. The prioritisation exercise should highlight those changes, impacts and vulnerabilities that require specific and urgent action. Criteria that might help this prioritisation include the timing of impact, the magnitude of impact, and the relevance of the impact to sectoral activities, priorities and objectives.

Timing of Impact

As part of the Climate Impact Screening (Step 2), the current and potential future impacts of extreme weather events, periods of climate variability and change were identified. This information should form a key component in prioritisation as consideration should be given to those impacts that are of immediate concern and where action can be taken to reduce detrimental consequences and realise immediate benefits. Particular attention should also be given to the future nature of projected changes with action taken in response to current variability and changes developed in concert with the projected changes in climate, including their timing.

Scale of Impact

As part of the previous step, an assessment of the magnitude of the current and potential future sectoral consequences of climate impacts was made. When prioritising climate impacts for further analysis, it is useful to consider how the level of impact/consequence might increase/decrease under projected changes in climate.

Policy Analysis

The impacts of climate change will be of relevance to existing sectoral priorities and objectives. By applying a climate lens to existing sectoral policy, aims and objectives, you will increase your understanding of how projected changes in climate, their impacts and consequences can act as a barrier or challenge, or can facilitate the achievement of sectoral development policy, strategies and action plans.

For example, the potential future impacts of climate change (projected increases in the frequency of extreme precipitation events) could lead to increased compliance difficulties with the EU Nitrates Directive regarding slurry storage and land spreading.

Before Moving On

Having completed the prioritisation of climate impacts for further analysis, you will have developed:

- ✓ A list of the priority changes and impacts that are or may in the future result in unacceptable sectoral consequences or potential benefits that would be lost if not actioned;
- ✓ Clear reasoning for and documentation of this prioritisation.

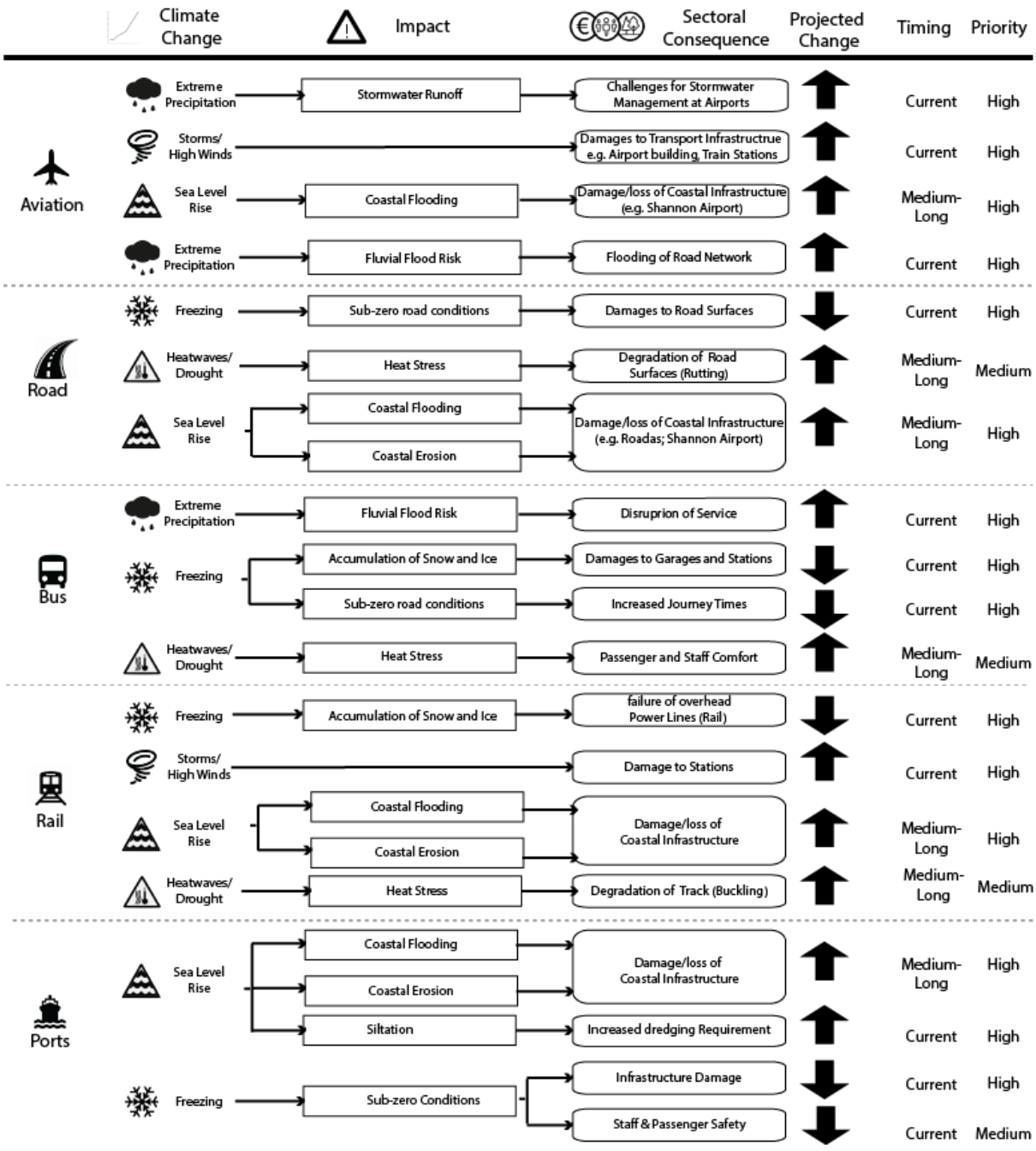


Figure 11 An example of priority climate impact chains developed for the Transport sector

4. Priority Impact Assessment (Step 4)

Now that the potential climate changes and impacts that are likely to affect your sector have been identified and prioritised, the SAT will undertake a more detailed assessment of those changes and impacts considered a sectoral priority and on this basis develop illustrative case study examples of these (Box 6). The more detailed assessment should provide sufficient information to inform step 5 (Developing you Plan) and the identification and assessment of adaptation options. This will involve:

- Providing a description of the impact under investigation including a description of factors that contribute to exposure and sensitivity;
- Providing a more detailed assessment of ongoing and projected future climate and weather-related impacts accounting for spatial and temporal variations in these and associated uncertainties;
- Developing plausible climate change and sectoral outcomes (impacts and consequences).

When undertaking this assessment, it is important to note that the initial Climate Impact Screening (Step 2) was based on current and projected future changes in climate conditions while other changes expected over time (e.g. population, land cover) were not included. As part of this assessment, it is essential to include existing projected socio-economic and sectoral information where available. When projecting socio-economic trends, it is important to recognise uncertainties in projections and it should not just be an extrapolation of historical trends. This is because different social and economic structures will affect sensitivity to climate change. For example, development of the built environment is giving rise to loss of biodiversity and in some cases climate change will exacerbate these pressures. In terms of agriculture, the effects of climate change on crops will depend on how many farmers have planted the crops, whether their farm income is dependent on that crop, in turn depending on agricultural subsidies, access to technology and so on (UKCIP, 2010). In addition, technological developments, such as improvement of weather forecasting may enable better precautions to be taken and along with improvements in preparedness diminish vulnerability to extreme weather events and periods of climate variability. To deal with uncertainties, sectoral studies often introduce a specific scenario altering a limited number of variables relevant to the sector under consideration. These scenario variables can address policy options (e.g. increasing output from agriculture) or autonomous socio-economic trends (e.g. increasing urbanisation) (UKCIP, 2010).

4.1 Provide a Description of the climate impact under Investigation

When describing the climate impacts under investigation, it is important to provide a description of sensitivity and exposure and according to the factors that contribute to both as this is where along with enhancing adaptive capacity adaptation efforts should be focussed. For example, for wind-throw, a number of factors contribute to the sensitivity of forest sites and these include: the soil type on which the stand was established, the altitude of the site and whether or not the stand has been thinned. In terms of exposure, wind-throw risk is greatest for those sites situated in areas where windspeeds are greatest and gusts more frequent, e.g. the southwest of Ireland. For adaptive capacity, the focus would be on enhancing knowledge and skills for site management to reduce vulnerability.

4.2 Assess Potential Future Climate Changes and Impacts

The first step of this assessment involves exploring the range of projected climate changes for Ireland. The rate at which levels of GHG concentration continue to increase is a key determinant of the extent of future climate change and a key source of uncertainty in projections of future climate. Due to uncertainties in how levels of future GHG emissions might change, projected climate changes for Ireland have been determined for a range of GHG emission scenarios. In combination, these scenarios of projected changes in Ireland's climate provide the range of changes which Ireland is likely to experience in the future (Figure 12).

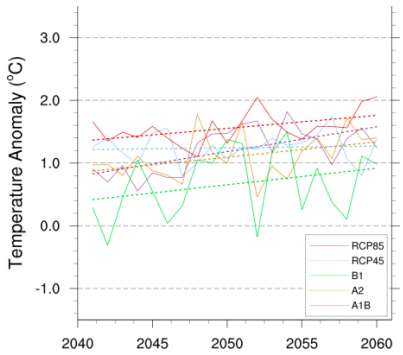


Figure 12 Projected change in annual average temperature for Ireland for the period 2040-2060 and for a range of emission scenarios (Nolan, 2015).

For relevant climate variables, observed and projected information should be documented as well as relevant information on the associated uncertainties, and this should include a description of:

- Observed spatial and temporal changes in the relevant climate variables;

- The range of projected changes in the climate variable and the overall direction of change (spatial and temporal);
- An assessment of consistency between observed changes to date and projected changes.

Climate Ireland's Climate Information Viewer provides information on observed and projected changes in key climate variables for Ireland.

Once you have detailed the relevant climate information, the next stage is to assess how projected climate changes and impacts might be manifested through changes in exposure and sensitivity. The procedure for evaluation of changes in impact involves estimating the change in level of impact between the reference (i.e. the current) and the future period. This assessment should provide a basis on which to assess the sectoral consequences of the range of future climate changes and impacts. There are two basic ways in which to undertake this analysis:

Impact models - impact models may be available that represent the complex and often nonlinear interlinkages between climate parameter and impact parameters e.g. areas flooded. However, when using these models, it is important to check underlying assumptions and to verify whether they are consistent with the assumptions of your assessment, e.g. the temporal and spatial resolution as well as the climate data employed.

Expert Knowledge - where quantitative data is lacking or deficient, previous experience of climate and weather-related impacts and an understanding of how biophysical impacts are manifest can be employed. This will involve providing a qualitative description of the potential biophysical impacts of projected climate change which should aim to address changes in terms of level of spatial exposure and the magnitude of change relative to the current situation. When assessing changes in biophysical impacts, it is recommended that you employ clearly defined indicators. These indicators should estimate the change in level of exposure (spatial and temporal) to the biophysical impact and can be quantitative (e.g. spatial extent of areas flooded), semi-quantitative or qualitative (e.g. increase in areas at flood risk).

Once you have established the range of potential future changes in the relevant climate stimuli and impacts and the associated uncertainties, gaps in knowledge should be identified and clearly documented. A lack of data or uncoordinated data collection can be considered a limiting factor but despite the data limitations and uncertainties of projected climate

changes and impacts (which are often greater than those associated with projected change due to cascading uncertainty), planning for climate change can and needs to happen now and addressing these limitations should be considered when identifying and selecting your portfolio of adaptation actions. For example, a clearly documented strategy to address these uncertainties and limitations should be developed (e.g. robust adaptation pathways). Documentation is critical to promoting and sustaining the actions but also for further iterations of the planning process. This strategy should outline the assumptions and rationale used in identifying and selecting your portfolio of adaptation options.

4.3 Sectoral Consequences

At this stage, an understanding of the range of projected climate changes and where and when climate impacts might be manifest should have been developed. The final step is summarising the sectoral consequences of these changes and impacts. This step is critical, as this summary will be used to identify where to focus your adaptation efforts and should highlight areas, systems and assets that are most sensitive to projected climate changes and impacts.

In contrast to the Screening Assessment (Step 2) which was based largely on current and historical trends, this stage of assessment should also consider expected socio-economic and sectoral changes over time (e.g. changes in population, development and landcover). In addition, this assessment should include an evaluation of adaptive capacity which refers to the ability of the sector to respond to adverse climate impacts. For practical reasons, integrating adaptive capacity as a status quo, i.e. its current condition, is recommended. This is to allow you to identify additional measures to increase your adaptive capacity as part of your adaptation plan (Step 5).

When undertaking an assessment of the sectoral consequences of climate change, the following information should be included:

- A description of the nature of the sensitivity of the sectoral activity to ongoing and projected climate changes. Where possible, describe quantitatively by change in bio-physical (e.g. crop production), socio-economic indicators and sectoral consequence (e.g. cost) - to date and in relation to projected changes in key climate parameters. Where impacts result from cross sectoral dependencies (e.g., supply chain), a description of these sensitivities should also be provided;

- A description of current adaptive capacity and its ability to offset the adverse sectoral consequences, e.g. are there sufficient measures available to offset adverse impacts or to take advantage of opportunities or benefits;
- Describe the scale and significance of the impact based on sectoral priorities and objectives.

Before Moving On

Having completed a more detailed assessment of climate impacts considered a sectoral priority, you should have:

- ✓ Examined and documented existing information on projected changes in relevant climate variables;
- ✓ Assessed how these changes might be manifest through impacts (biophysical and socio-economic) and have developed an understanding of when and where these might occur;
- ✓ Identified and documented sensitivities and exposure of the sectors to these impacts;
- ✓ Produced (or completed) an assessment of the sectoral consequences of projected impacts and the ability of the sector to adapt to these (i.e. the adaptive capacity); and
- ✓ Clearly document assumptions made and rationale behind the resulting decisions leading to the assessment conclusions.

Wind-throw in the Forestry Sector

Wind-throw has been identified as an impact of particular concern for the forestry sector and occurs when trees are blown down. While wind tolerance varies among tree species, four factors contribute to the sensitivity of wind-throw: the top height of the stand – the taller the trees the more likely they are to be affected; the soil type on which the stand was established, the risk of wind-throw is greater in stands on wet soils such as gleys and blanket peats; the altitude of the site – higher wind-speeds are recorded at higher altitudes; whether or not the stand has been thinned – opening up the canopy increases wind-throw risk although early thinning can make stands more stable. Currently, wind-throw risk is greatest in the southwest where wind-speeds are greater and gusts more frequent. Stands in the east of Ireland are less exposed to wind throw risk.

Current Effects of Wind-throw.

The winter of 2013/2014 was wetter than average and storm force winds occurred on 12 separate days between December 2013 and February 2014. This led to a large increase in rainfall on land which was already heavily saturated. The frequency and ferocity of the storms, compounded by waterlogged soils, resulted in extensive wind-throw of approximately 8000 ha (+/- 560ha), with counties Kerry, Limerick, Cork and Clare most affected. Figure 1 details the damage caused by this storm and outlines the spatial aspect of the damage which can occur as a result of a severe wind-throw event.

Following the events of 2013/2014, a wind-blow taskforce was established and resulted in, inter alia, the prioritisation of processing of the applications for felling licences within DAFM.

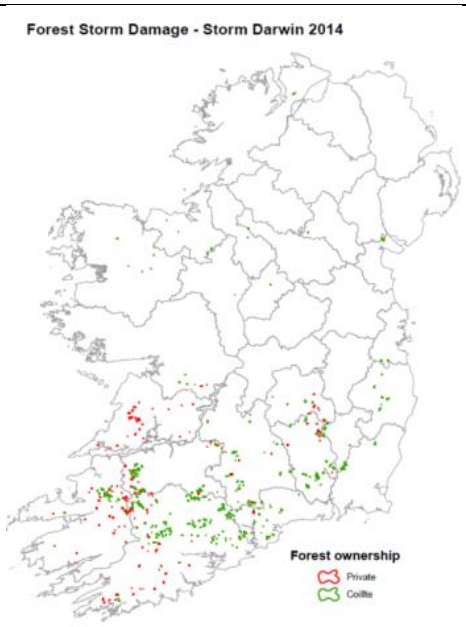
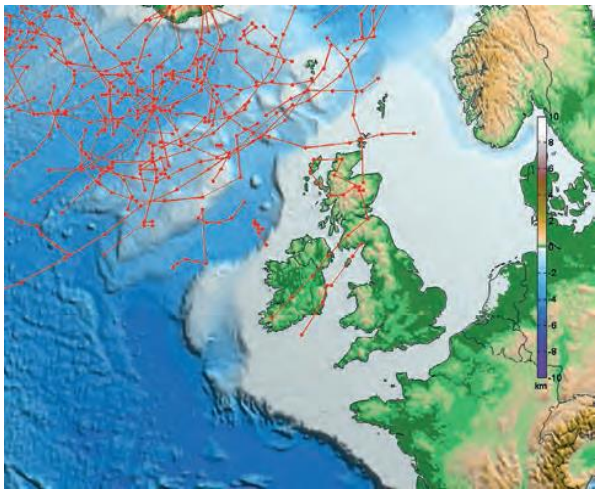


Figure 1 Locations of sites damaged as a result of Storm Darwin, 2014.

Projected Changes in the Occurrence of Wind-throw

Projections for both high and low-medium emissions scenarios indicate an increase in very intense windstorms over Ireland as storm tracks extend further south by mid-century. Figure 2 presents past (1981-2000) and projected (2041-2060) extreme storm tracks, as simulated by the high-emission ensemble of RCMs (Nolan, 2015).



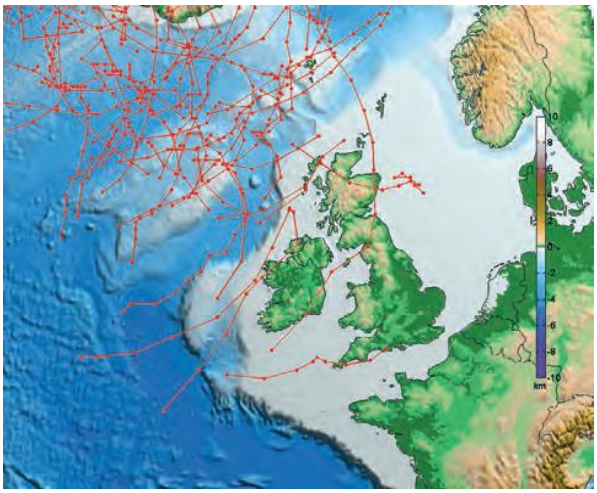


Figure 2: Past (1981 – 2000) & Future (2041-2060) Tracks of Storms with MLSP less than 940hPa & at Least 12 Hours Lifetime (Nolan, 2015).

Wind-throw risk models have been developed for Irish forestry (Ni Dhubhain, 1998), based on probability of wind-throw risk using a number of stand and site variables. However, these models are not linked to future climate change scenarios to account for the higher frequency of cyclones and increased wind speed on stand stability in the future. Nonetheless, past experience demonstrates the potential effects of wind-throw for the forestry sector and projected increase in the frequency of storm events is likely to increase the risk of wind-throw in the future (both spatially and temporally).

Sectoral Consequences

Experience has shown the consequences of wind-throw for the forestry sector:

- Health and Safety risks both during and after the event;
- Loss of commercial forest stock and likely short term decrease in forest prices;
- Large disturbances influence forest age and class structure with environmental and economic implications.

Due to the relatively long life-span of the forestry cycle, the impacts of climate change (including wind-throw) are expected to have significant impacts on forest productivity and may challenge the strategic goal of the forest sector in Ireland which is "to develop an internationally competitive and sustainable forest sector that provides a full range of economic, environmental and social benefits to society and which accords with the Forest Europe definition of sustainable forest management" (DAFM 2014a). Afforestation is a major GHG mitigation measure being taken on agricultural land. Between 1990 and 2030 €3.5billion will be invested in afforestation. However, large wind-throw events and the subsequent economic and physical impacts could affect the burgeoning forest management culture in Ireland. Large wind-throw events could also result in the temporary derailing of the management of long term goals for the sector as resources are used to manage immediate, high priority issues. For example, applications for felling licenses required as a result of storm damage were prioritised following the 2013/2014 wind-throw event. In addition, the experience of ill prepared or relatively new forest owners during large wind-throw events could result in the resurgence of the negative attitude to forestry land use noted by Malone (2008).

Box 6 An example of an more detailed assessment of wind-throw for the forestry sector.

5. Develop your Plan (Step 5)

Upon completion of the vulnerability assessment and prioritisation, the SAT should have sufficient information to inform the identification and selection of the required adaptation efforts. Developing your adaptation strategy will consist of establishing goals, sequencing objectives and identifying and prioritising actions that can help you in achieving these.

5.1 Identify Goals and Objectives

After reviewing the vulnerability assessment and priority concerns, the adaptation team should identify adaptation goals. Goals are general guidelines and are generally long term and broad statements while objectives outline the steps to achieve these goals. It is important, however, to note that identified goals and objectives may change over time, based on new scientific findings, improved vulnerability assessment, observed climate impacts and consequences, socio-economic, political and technological changes, and implementation successes and failures.

In consultation with your adaptation team, review your vulnerability assessment and identify your adaptation goals. When undertaking this task, it is also useful to review goals established in other plans and programmes and from adaptation plans from other sectors and organisations to identify potential enabling mechanisms or conflicts that will need to be considered within your plan

Once you have identified your broad and general adaptation goals, identify objectives that will help you achieve these goals. It is important that these objectives are clearly written, attainable and measureable, and include assumptions and rationale. When identifying adaptation goals and objectives, it can be useful to do this in sequence. For example:

Goal :	*Reduce the vulnerability of critical assets to Sea Level Rise*
Objective 1:	*Increase support for climate change adaptation including taking measures to build adaptive capacity, including awareness of the risks and benefits of climate change and adaptation.*
Objective 2:	*Increase and improve technical capacity to project impacts of climate changes*
Objective 3:	*Reduce economic, social and environmental losses related to SLR*

Table 4 An example of goals and objectives in relation to the vulnerability of critical assets to sea level rise.

5.2 Identify Actions

Adaptation actions will help you to achieve your objectives. It is likely that no single adaptation action will help you achieve your objectives and that a portfolio of actions (working in concert to deliver the objective) will be required. Adaptation actions can be usefully classified into those that either build adaptive capacity or deliver progress in responding to climate change.

Adaptive capacity refers to your ability or potential to respond successfully to climate change and building adaptive capacity refers to measures that develop your capacity to adapt and includes actions such as:

- Impact Identification and Assessment – In order to plan effectively for adaptation to climate change, there may be a requirement to increase your knowledge and skills including understanding of the sectoral impacts and consequences of climate change including thresholds, sensitivities, dependencies and interdependencies. As such, actions to increase understanding of climate impacts and consequences may be required and would include actions such as: research and data collection, monitoring, modelling and mapping.
- Raising awareness and understanding – Adaptation will require making trade-offs and dealing with conflicts, identifying potential synergies with other actions (including sustainable development) and dealing with institutional and organisational barriers. As a result, in order to support the implementation of these measures, there will be a requirement for buy-in from all stakeholder groups. As a result, raising awareness and understanding amongst stakeholders might be a first step in supporting the delivery of adaptation actions.

Delivering adaptation actions involves taking practical actions to reduce vulnerability to the negative impacts of a changing climate and enhance opportunities or benefits. These encompass a wide range of actions and can be classified as soft, green or grey and may range from simple solutions to large scale transformational projects.

- Soft adaptation involves alteration in behaviour, regulation or system of management, examples include: Extending timeframes of plans further into the future; zoning development away from sensitive areas; and instituting or strengthening building codes in hazard prone areas.
- Green adaptation measures seek to utilise ecological properties to enhance the resilience of human and natural systems to climate change impacts. For example,

increasing green space in urban areas could provide areas for retention of floodwaters and significantly ameliorate the impacts of rising surface temperatures resulting from climate change;

- Grey adaptation measures involve technical or engineering solutions to climate impacts, examples include raising roads where flooding is expected to occur.

At this stage of the assessment and when planning your climate actions, identify as many actions as possible consistent with and capable of contributing to your climate adaptation objectives. It is important to note that some actions will address a number of your adaptation objectives and goals.

- It can be useful to first identify the range of additional options required to offset current impacts and with reference to future vulnerabilities and projections of climate change, identify additional actions;
- For those measures for implementation in the long term and in order to address emerging climate risks, it can be useful to identify the range of options required to address long term objectives and work backwards from these to identify what might be needed in the short term to and to establish the timing of these adaptation options sequentially.
- As illustrated in Figure 13, an adaptation pathways approach provides a useful means by which to structure and subsequently communicate this information (Siebentritt et al., 2014). An adaptation pathways map is a schematic diagram of adaptation options and the relationships between them, 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:

    - Managing Uncertainty - Pathways support a structured approach to the modification of adaptation responses in light of new information, changing circumstances of societal priorities;
    - Transparency - pathways makes explicit the assumptions, trade-offs and aims of adaptation efforts in a way which is communicable;
    - Risk-based decision thresholds - thresholds of acceptable risk can be explicitly used as decision trigger points, with alternative adaptation measures being flagged as necessary in advance of risk thresholds being reached (Gray, 2016).

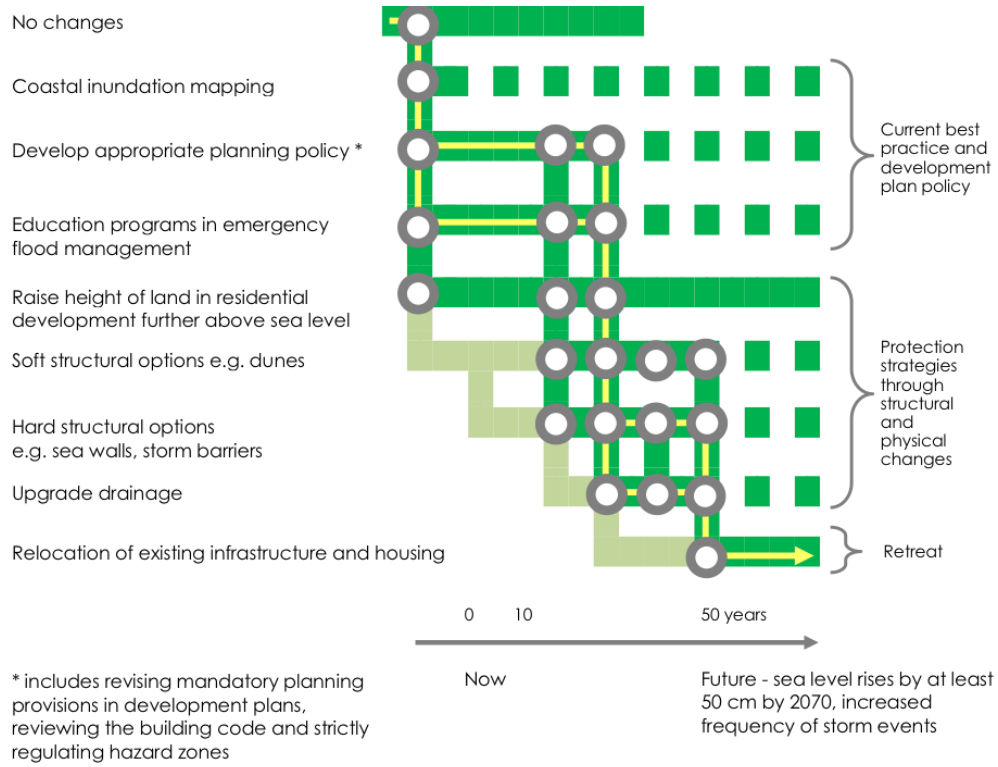


Figure 13 An example adaptation pathway from the Eyre Peninsula, for Agriculture/Urban Infrastructure (source Siebentritt et al. 2014). The map identifies adaptation options on the y-axis while the x-axis represents the time and a general trend in changing climate which should be read as indicative (e.g. decades) rather than precise in terms of timing of the adaptation options. A solid dark green line indicates the time period over which an option could usefully address the relevant decision, a lighter green line indicates time before an action occurs and where preparatory work is required. A dashed thick green line indicates that the option contributes to the adaptation solution but only in part. Circles indicate a decision point, where a choice between different options might need to be made while the yellow lines with arrows indicate an emerging pathway.

Goal – Reduce Vulnerability of Critical Assets to Sea Level Rise	
Objective:	**Potential Actions:**
Increase support for climate adaptation;	Launch the adaptation plan; Develop public summary; Develop In-house summary; Develop an outreach strategy; Engage stakeholders in the planning and monitoring efforts; Monitor the impacts and consequences (develop the business case); Monitor plan implementation.
Increase and improve technical capacity to project impacts of climate changes;	Research and data collection (Review climate change research); Monitor impacts and consequences; Modelling and Mapping; Co-ordinating research agendas with other sectors/academic institutions.
Reduce loss related to SLR.	Shoreline management plans; Acquisition, demolition and relocation; setbacks; Infrastructure protections; Include climate consideration in all aspects of planning; work with Local government for land management.

Table 5 Example of objectives and potential actions to achieve the goal of reducing vulnerability of critical assets to sea level rise.

5.3 Assess, Select and Develop Adaptation Action Plans

Now that you have identified a wide range of adaptation options on the basis of your identified goals and objectives, the next step is to develop your adaptation action plans. On the basis of the options identified through Step 5.2, decisions will have to be made on which of the identified actions are actually suitable for implementation. This will involve undertaking an assessment of the identified actions. A useful method to assess identified actions is to use a method that considers the **S**ocial, **T**echnical, **A**dministrative, **P**olitical, **L**egal, **E**conomic and **E**nvironmental opportunities and constraints of each action. The results of the assessment will help the planning team decide on the benefits and disadvantages of each action and to determine which actions are best suited to current capacity and resources. At this stage of the assessment, however, it must be remembered that there are no right or wrong answers.

Consideration	Key Questions:
***S**ocial*	- *Will the action be socially acceptable?* - *Is it compatible with community values?*
***T**echnical*	- *Is the action technically feasible?* - *Will the action reduce long-term loss?* - *Are there any indirect effects?*
***A**dministrative*	- *Can the sector meet the staffing and funding needs of the action or does it need to be obtained elsewhere?*
***P**olitical*	- *Is there political support for the action?* - *Is there enough public support to ensure the success of the action?*
***L**egal*	- *Does the sector have the authority to implement the action?*
***E**conomic*	- *Is the action cost-effective and likely to pass a cost-benefit analysis?* - *What benefits will the action provide?*
***E**nvironmental*	- *How will the action affect the environment?* - *Is the action consistent with environmental goals?*

Table 6 Examples of considerations and questions to pose when assessing adaptation actions.

Once you have prioritised and agreed your adaptation options with which to move forward, a brief action plan should be developed for each action. These will establish accountability and ease tracking and evaluation as outlined in the next step. Information that could be captured includes:

- Title
- Responsible Body(s)
- Priority
- Cost-benefit Analysis
- Assumptions that were considered when identifying the action
- Risks associated with implementation
- Barriers and enablers to implementation
- Additional adaptation measures that may need to be included
- Milestones
- Evaluation Plan
- Description
- Other Players
- Costs
- Potential Funding Source(s)
- Maintenance Needs
- Goals Addressed

Once you have provided detail for each adaptation action, it can be useful to develop an implementation and monitoring plan which sequences the full range of adaptation actions. This is useful in helping to guide and evaluate the progress of the plan (Step 6). The implementation plan should also play a role in communicating your adaptation plan and should include an engagement and dissemination plan. For example, and as illustrated Figure 14, for transport, a key goal is to reduce the vulnerability of coastal infrastructure to the impacts of sea level rise and coastal inundation. In the short term and in order to support the delivery of medium and longer-term actions, four measures were identified as being preparatory for these actions and to increase buy-in and support for the implementation of actions in the medium and long term. These measures involved launching the adaptation plan to initiate wider engagement; monitoring of the impacts and consequences of the plan, including in the context of changes in climate and extreme events, to establish the business case for climate adaptation. In addition, and in order to support future adaptation measures,

an audit of existing plans and policies should be undertaken. Due to existing and emerging dependencies and interdependencies, co-ordination with other sectors and agencies is also deemed necessary in order to enhance awareness and to increase and improve technical capacity for climate change adaptation. Following from this, research, data collection and training were identified as being a pre-requisite to allow for future modelling and mapping activities to support decisions to be taken in achieving the overall adaptation goal of reducing vulnerability of critical infrastructural assets to climate changes.

Before Moving On

Following Step 5, you will have:

- ✓ Identified your sectoral adaptation goals and objectives;
- ✓ Identified a range of actions to help you achieve goals and objectives;
- ✓ Developed an implementation and monitoring plan to support delivery of these actions.

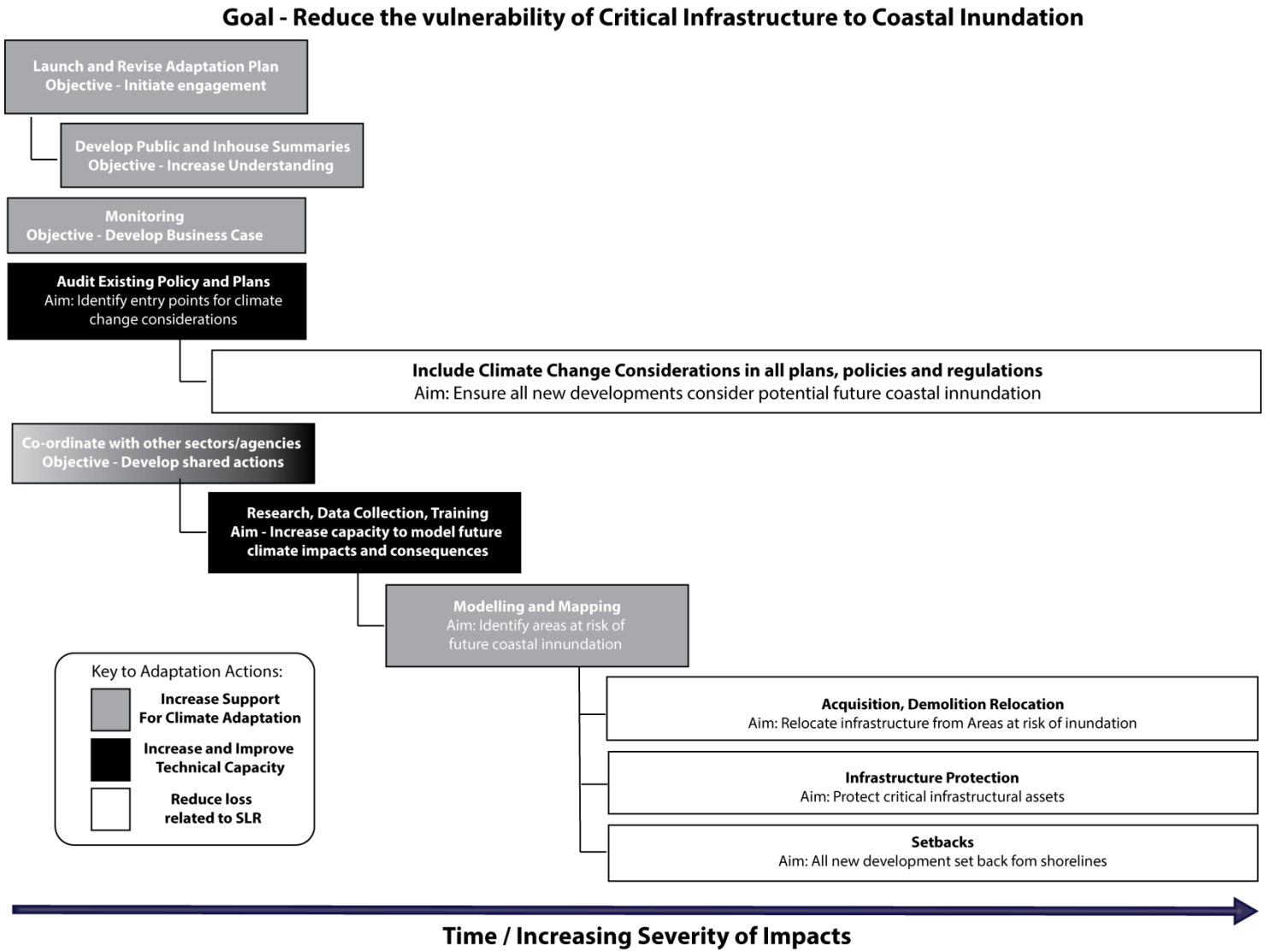


Figure 14 An example of adaptation options sequenced for implementation in the short, medium and long term to reduce the vulnerabiliy of critcial infrastructure to coastal inundation.

6. Implement, Evaluate and Review (Step 6)

The final step of planning involves the implementation, monitoring and evaluation of the plan. This involves ensuring that the plan is widely disseminated, includes effective tracking and evaluating the progress and continued validity of the plan, communicating plan progress and assessing the need to update the plan. It is also important to remember that the underlying science and socio-economic conditions are evolving and to account for this, the plan will have to be subject to review and update, and be flexible enough to accommodate revision.

6.1 Implement the Plan

Prior to adopting the plan, the SAT team will need to determine whether Strategic Environmental Assessment (SEA) and/or Appropriate Assessment (AA) of the plan is required.

Strategic Environmental Assessment and Appropriate Assessment

Appropriate Assessment (AA) – The EU Habitats Directive requires an AA to be carried out where a plan or project is likely to have a significant impact on a Natura 2000 site which include Special Areas of Conservation (SAC) and Special Protection Apreas (SPAs).

Strategic Environmental Assessment (SEA) – The SEA Directive (2001/42/EC) requires that environmental considerations are fully integrated into the preparation of Plans and Programmes and prior to their final adoption. For the eleven SEA sectors specified in the directive, Competent Authorities (Plan/Programme makers) must subject specific plans and programmes to an environmental assessment where they are likely to have significant effects on the environment.

The EPA have compiled a Strategic Environmental Assessment pack which comprises a combination of guidance, checklists and reference materials for use in the SEA and Plan making process, click here to access

Box 7 Strategic Environmental Assessment and Appropriate Assessment.

Once the plan has been adopted, it is important that you disseminate the plan widely and acknowledge the contribution of stakeholders, this is because actions arising from the plan will require stakeholder support and in several cases, stakeholder action. With the goals and objectives in place, you will turn your focus to the action plans which will guide the implementation of the plan and the individual actions arising out of the plan, including monitoring and evaluation.

The ultimate goal of adaptation planning is to integrate adaptation into all sectoral plans and programmes. As identified through the adaptation planning process, there are a number of sectoral plans and programs that will have a role in implementing adaptation actions. These plans and programs can benefit from the adaptation plan but there may also be potential conflicts. Benefits should be used as vehicles to implement adaptation actions identified in the adaptation plan while conflicts should be monitored to identify where further actions may be needed to realise the identified adaptation goals and objectives.

6.2 Monitor and Evaluate

Once the plan has been implemented and to ensure the effectiveness of the adaptation plan and demonstrate its progress, there will be a requirement to continuously track the actions outlined in the plan and evaluate the plan's progress in meeting its goals. By designing a tracking and evaluation programme as part of the implementation plan, the planning team will be in a good position to demonstrate the plans contributions and to identify where and when further actions are needed. This programme should identify schedules and milestones for individual adaptation actions and there should be a clear identification of responsibilities for monitoring and evaluating, and clear criteria for signalling that the specific actions need reconsideration. As the impacts of climate change remain uncertain, however, it may be difficult to assess the level of success or lack of success of some adaptation actions in the early years. When developing your tracking and evaluation programme, things to consider include:

- How often should the planning team meet to review progress;
- How will the planning team keep senior management updated on progress;
- How will other sectors be kept informed of plan progress to ensure that synergies and cross-benefits between plans are fully realised;
- How should progress be reported to the stakeholder group, e.g. progress reports;
- What are the key signals (thresholds) for updating the plan.

6.3 Update the Plan

The adaptation plan is a living document and it is essential that this document is updated to ensure that it stays up to date with evolving science, socio-economic considerations and experiences. As a result, in addition to reviewing the adaptation plan on a regular basis and where and when the monitoring and evaluation identify the need, it is also important that you schedule a full scale update every few years (e.g. 3-5 years). It is important that you plan

ahead for these updates and ensure that all relevant data, e.g. monitoring, is collated through time. In order to ensure this, it can be useful to assign tasks to team members.

Before Moving On

Following this step, you should have:

- ✓ Implemented the plan;
- ✓ Developed a monitoring and evaluation programme for identified actions;
- ✓ Developed a plan to update and periodically update the plan.

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