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Climate change governance: enhancing local authorities' adaptive capacity

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Thesis submitted in fulfilment of the requirements of the PhD degree,

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February 2015

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Abstract

Climate change is a wicked problem that threatens our way of life through environmental changes and governance challenges. Reducing vulnerability requires actions by all formal government structures and society. While much is known about local governance challenges internationally, information has been lacking about the Irish context. Little work has been done concerning how climate change will affect Irish local authorities, how advanced their preparations are, and factors affecting their progress.

This is the first comprehensive study in Ireland on climate change governance framed at the city and county level. This research evaluates climate change implications for Irish local authorities and explores ways to enhance their adaptive capacity. This is done through a multi-faceted approach. Climate change exposures were evaluated and ranked through an analysis of local policy documents such as the City and County Development Plans and Climate Change Strategies. An assessment of sectors under local authorities' remit, such as flooding, landslides, water supply, biodiversity and coastal management, was completed for each jurisdiction. The potential for enhancing adaptive capacity was explored through two nationwide surveys involving all 34 planning authorities. Case studies with four local authorities were completed to provide greater insight into the approach of local authorities to prepare for climate change. Seven higher level interviews were conducted with senior officials in two regional authorities and national officials of the Department of Environment, Community and Local Government to explore the links between central government policies and local government implementation.

The research findings highlight the importance of considering governance factors. While challenges for exposures and capacities were greater for some local authorities than others, local authorities were more challenged by governance aspects than climate change per se. It is concluded that an integrated approach is needed that links together local expertise and innovation with strategic guidance from central government. The findings identified a pathway for local and national governments to effectively co-operate in addressing climate change adaptation. Without this, preparations for climate change and understanding of climate change governance will leave society unprepared for the upcoming challenges related to climate change and general environmental issues.

Acronyms

AIEA	Association of Irish Energy Agencies
C4I	Community Climate Change Consortium for Ireland
CEC	Commission of the European Communities
CFRAMS	Catchment Flood Risk Assessments and Management Studies
CSO	Central Statistics Office
CORINE	Coordination of Information on the Environment
DECLG	Department of the Environment, Community and Local Government
DEHLG	Department of Heritage and Local Government
DELG	Department of Environment and Local Government
DEM	Digital Elevation Model
EEA	European Environment Agency
EIA	Environmental Impact Assessments
EPA	Environmental Protection Agency
GDSDS	Greater Dublin Sustainable Drainage Study
GHG	greenhouse gas emissions
GSI	Geological Survey of Ireland
HadCM3	UK Hadley Centre Global Climate Model
ICARUS	Irish Climate Analysis and Research Units
ICLEI	International Council for Local Environment Initiatives
ICZM	Integrated Coastal Zone Management
IPCC	Intergovernmental Panel on Climate Change
NCCAF	National Climate Change Adaptation Framework
NCCS	National Climate Change Strategy
NHA	Natural Heritage Areas
NPWS	National Parks and Wildlife Services
OECD	Organisation for Economic Co-operation and Development
OLAM	Office for Local Authority Management
OPW	Office of Public Works
PLUTS	Planning Land Use Transportation Studies
RAL	Remedial Action List for Public Drinking Water Supplies
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessments
SEAI	Sustainable Energy Authority of Ireland
SEAP	Sustainable Energy Action Plans
SERA	South-East Regional Authority
SPA	Special Protection Areas
SRES	Special Report on Emissions Scenarios
SUDS	Sustainable Urban Drainage Systems
UNFCCC	United Nations Framework Convention on Climate Change
WRA	West Regional Authority

Acknowledgements

This research was supported through funding, input from government agencies, academics, and my friends and family. Funding is gratefully acknowledged from two sources: the John and Pat Hume Research Scholarship and the EPA Climate Change Research Programme 2007-2013.

I acknowledge input from staff members of local authorities, regional authorities, the Department of the Environment, Community and Local Government, the Geological Survey of Ireland, and the Office of Public Works. They provided me with data over the period of this research and allowed for some insights into the inner workings of government.

I offer special thanks to Professor John Sweeney and Dr. Ronan Foley as my supervisors. John Sweeney's open door policy and generosity with his time, guidance and encouragement were invaluable to my completion of this research. Ronan Foley graciously read and provided detailed comments on drafts of the thesis throughout the process. I also extend my thanks to Jan Rigby who read and provided insightful comments on my thesis.

On a more informal note, I am grateful to the staff and postgraduates of the Department of Geography at Maynooth University for making it such a special place. The collegial and supportive atmosphere provides a space for people to explore new ideas, grapple with challenges, and gain new insights into their research area and themselves.

Last but not least, my friends and family, here in Ireland and abroad, have helped me through the process, and their unfailing support and faith in me helped make this thesis possible.

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Chapter 1. Introduction

Climate change threatens our way of life (Pittock and Jones, 2000; Irish Academy of Engineering, 2009). It will present new challenges related to the physical environment and our responses to these changes. Our physical environment is changing: precipitation patterns are changing, sea level is rising, and natural systems are affected. The existing infrastructure of homes, commercial buildings, transportation networks and recreation facilities are based on existing conditions which have been relatively stable. However, scientists, as reported in the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports, have tracked observed changes and have predicted future changes through climate modelling (Stocker et al., 2013).

Climate change poses an even greater challenge from a governance standpoint. Governance addresses the interactions within government as well as between government and the private sector. These interactions involve a wide range of actors including governments, semi-state entities, non-governmental organizations, and private interest groups (Kjær, 2004). To address climate change, policymakers are challenged to balance current priorities and long-term goals. Further, climate change presents what is known as a 'wicked problem': one that is difficult to solve because it has elements that are uncertain and complex (Head, 2008). Even the very definition of the problem cannot be easily answered nor its optimum solution addressed with a quick fix (Rittel and Webber, 1973; Hulme, 2009; Hartmann, 2012; Jones et al., 2014).

Planning for climate change raises other questions as well. The question still remains as to why governments and society do not always address environmental hazards, even when vulnerability has been assessed (White, G.F. et al., 2001; Tompkins et al., 2010; Berrang-Ford et al., 2011). Another question is whether local actions are prompted by local circumstances or higher level requirements. Overall, though, responses to climate change will require an integrated approach that considers the interactions between the local, national and global scales (Wilbanks and Kates, 1999).

Given the foregoing challenges and outstanding questions, this thesis focuses on the physical climate part of the problem as well as the governance part of the problem. This chapter begins with a summary of the physical climate science, evaluates what is known about Irish preparations for climate change, identifies the research aims for this study, and concludes with an overview of the thesis structure.

1.1. Observed and projected climate change

Climate scientists have quantified trends associated with climate change. The global information gives an overview of these trends, but coarse resolution and uncertainty about the extent of future changes inhibits national and local preparations. In addition to global information, research has been carried out at a national scale to help expand information appropriate for Ireland. The information, based on the observations and projections, provides a starting point for local authorities to meet challenges presented by climate change. As described below; the most relevant changes for local governments are greenhouse gas concentrations, temperature increases, changing precipitation patterns, sea level rise, and storm surge. Lastly, the related impacts are summarised in within this section.

1.1.1. Greenhouse gas concentrations

Greenhouse gas concentrations, including CO_2, are a driving force for long-term climate variations (Arrhenius, 1896). Observed global CO_2 concentration has increased from preindustrial levels of 278 ± 2 ppm in 1750 to current levels of 390.44 ± 0.16 ppm in 2011 (Hartmann et al., 2013). Irish records are similar, with concentrations of 390 ppm measured at Mace Head in County Galway (Dwyer and Ramonet, 2012). Projected greenhouse gas concentrations will increase globally to 475-1313 ppm by 2100 (IPCC, 2013:29). These concentrations are affecting temperatures, precipitation patterns, sea levels, and other processes in the physical environment.

1.1.2. Temperature increases

Observed global mean temperature has increased by 0.72 to 0.85^{0}C between the 1850-1990 period and the 2003-2012 period (Hartmann et al., 2013). Irish temperatures have increased by approximately 0.8^{0}C over the last 110 years (Walsh and Dwyer, 2012). Projected global temperatures will increase between a low of 0.3°C to 1.7°C and a high of 2.6°C to 4.8°C between the current period (1986-2005) and the end of the century (2081-2100) (Collins et al., 2013). Irish mean temperatures are projected to increase in all seasons, with greatest increases in the autumn (September – October) of 1.8°C by the 2050s and 2.7°C by the 2080s (Fealy and Sweeney, 2008).

1.1.3. Sea level rise and storm surge

Observed global average sea level has risen by 1.5 to 1.9 mm yr^{-1} between 1901 and 2010, and 2.8 to 3.6 mm yr^{-1} between 1993 and 2010 (Rhein et al., 2013). Similar to the longer global trend, average sea level in the British Isles rose by ~1.0 mm yr^{-1} in the last 100 years (Woodworth et al., 1999; Fealy, 2003). Ireland's record shows less change with a small decrease for Belfast (-0.99 and -0.25 mm yr^{-1} for two locations) and slight increase for Malin Head (0.06 mm yr^{-1}) and for Dublin (0.23 mm yr^{-1}) (Woodworth et al., 1999; Fealy, 2003). Recorded storm surge events have occurred as in the case of Dublin City's extreme flooding in February 2002 (OPW, 2004).

Global sea level is projected to rise, and the effects will be compounded by increased storm surges. By 2100, it will increase by at least 0.26 to 0.55 m, according to lowest projections; and by as much as 0.45 to 0.82 m according to the highest projections (Church et al., 2013). The Irish Sea level is projected to increase by approximately 0.47 m by 2100 (0.31 m from thermal expansion and 0.16 m from increased mass from glacial melt and decreased terrestrial water storage) (Olbert et al., 2012). Of note, some researchers counter that the amount of sea level rise around Ireland has not been confidently quantified (Fealy, 2003; Devoy, 2008; Dunne et al., 2008). Storm surges are projected to increase in frequency (10.6 - 30.53%) and height (10.6 - 30.53%) by mid-century (Dunne et al., 2008).

1.1.4. Precipitation patterns

Observed global precipitation patterns have changed. Precipitation increased in interior parts of the northern and southern hemisphere between 1990 and 2005. During the same period, decreases were noted in the Mediterranean, Sahel, southern Asia and southern Africa. Precipitation has also changed in intensity, frequency and type (Hartmann et al., 2013). In Ireland, annual precipitation increased between 1960 and 2005, with greatest increases in the west of 15 - 20% (McElwain and Sweeney, 2007). Irish seasonal distributions are mixed for frequency and intensity. The frequency of wet days has decreased in some locations by as much as one day per decade, and increased in other locations by as much as five days per decade. Heavy rain day intensity has decreased in some locations by as much as three days per decade, and increased in other locations by as much as five days per decade (Walsh and Dwyer, 2012).

Projected global precipitation patterns will vary with increases in some regions such as South Asia and decreases in other regions such as mid-latitudes (Collins et al., 2013). In Ireland, the rainfall projections show increases above baseline levels (1961-1990) in winter of 10% by the 2050s and 11-17% by the 2080s, and decreases below baseline levels in summer of 12-17% by the 2050s and 14-25% by the 2080s (Sweeney, 2008). However, the greatest winter increases will be in the west and the greatest summer decreases will be in the southeast (Fealy and Sweeney, 2008).

1.1.5. Impacts related to climate change

Irish temperatures will increase with wetter winters resulting in increased seasonal flooding, and drier summers with increased water shortages during the summer months. These climatic changes will produce impacts across a wide spectrum, particularly affecting water resources, agriculture, forestry, biodiversity, and marine and coastal environments (Sweeney et al., 2003; Dunne et al., 2008; Sweeney et al., 2008). For example, sea level rise coupled with increased storm surges expose coastal areas to saltwater inundation and coastal flooding (Fealy, 2003). In addition, Ireland's risk for landslides may increase with projected climate change (Creighton, 2006; Dykes et al., 2008; Collins, 2013). Landslides affect transport links and water supplies (Donnellan, 2000; MacNally and Shiel, 2003; Lucey, 2008).

The global and national climate information still lacks details for local authorities about what is likely to occur in their areas as well as how their areas fit into the national picture. Some areas will experience greater impacts, and others will have less severe impacts. These impacts present a challenge for policymakers because there is uncertainty about the extent, precise location, and timing of changes (Irish Academy of Engineering, 2009). Current impacts illustrate this challenge. For example, intense storms in February 2014 resulted in widespread flooding. In the Waterford City case, the OPW addressed flood risk on the quays with €24.5M in flood alleviation works (O'Donovan, 2014). The city was protected in these areas; however, other parts of the city still experienced flooding (Waterford City Council, 2014; Seanad Debates, 2014). The current impacts, such as flooding, will worsen with climate change and preparations to deal with climate change should already be well underway to adequately protect people and the environment.

1.2. Irish preparations for climate change

Preparations for climate change are needed in Ireland, as shown by the foregoing scientific research, and the public supports the need for adaptation. While not a first priority, people recognise the responsibility of governments and private actors to address climate change. This is important because governments' capacity is affected by external factors, e.g. public support, as will be discussed in Chapter 2.

Information about public opinions on climate change is mixed. At first, it may appear that the public are not concerned about this issue as reported in the 2014 Standard Eurobarometer Survey: very few people cited climate change as one of the two most important issues currently facing the EU (EU 5%, IE 4%) (Commission European Communities (CEC), 2014b). But when the issue of climate change is raised, a more favourable picture emerges. In the 2013 Eurobarometer Survey about Climate Change, most people perceived climate change as a very serious (61%) or fairly serious (33%) problem (CEC, 2014a). Furthermore, when responsibility is considered, national governments, the EU and individual responsibility were the most commonly cited as responsible for tackling climate change (Figure 1.1).

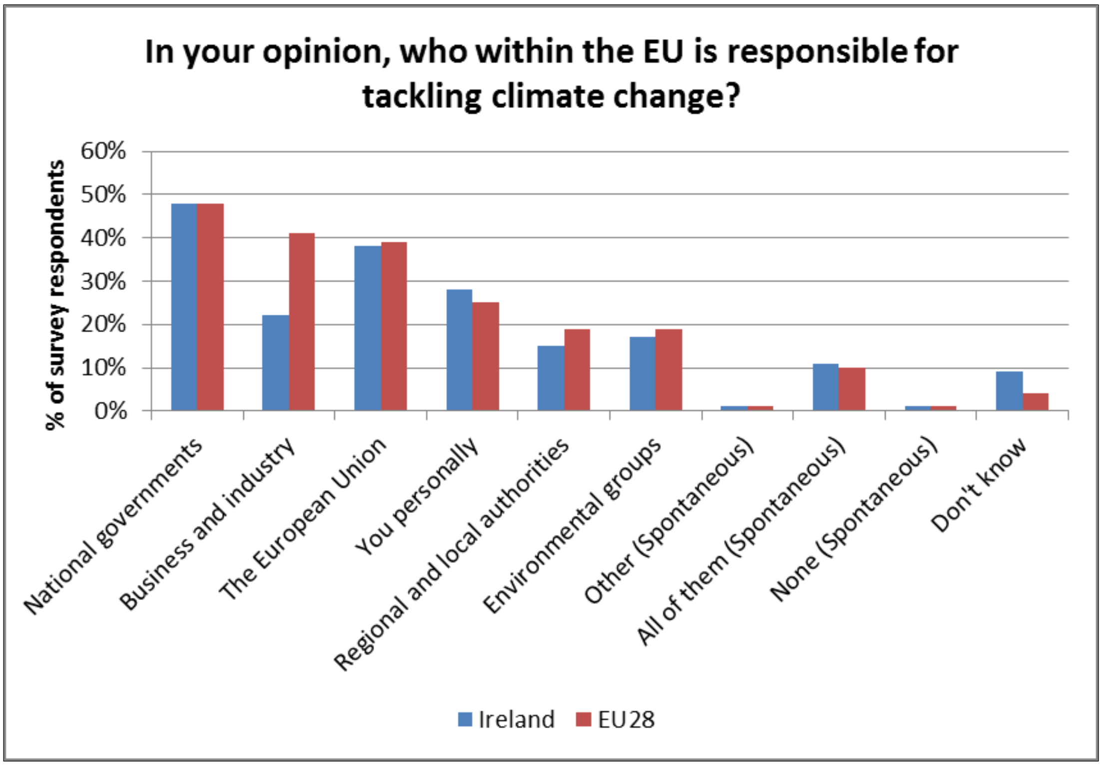

Figure 1.1 Climate change responsibility in Eurobarometer Survey (CEC, 2014a)

Therefore, Irish preparations for climate change are needed. To provide context, a review of these preparations by all government levels within Ireland (national, regional and local) are considered based on the need for an integrated approach (Wilbanks and Kates, 1999).

1.2.1. National government

Three national policies since 2000 have specifically focused on climate change, but they have limited specificity and scope, and address few adaptations. More general policies have very limited climate change provisions. Also at national level, but beyond just government policies, semi-state and professional bodies have publicly addressed climate change.

The climate change policies include: 1) the *National Climate Change Strategies* (NCCS) in 2000 and 2007, 2) the *National Climate Change Adaptation Framework* (NCCAF) in 2012, and 3) the proposed *Climate Action and Low-Carbon Development Bill 2015* initiated January 2015 and published 19th January 2015. First, the 2000 NCCS focused on mitigation commitments with a brief acknowledgement of impacts and generic discussion of possible adaptation (DELG[1], 2000:15). This strategy acknowledged the rising costs of adaptation and hence the burdens on future generations. Similarly, the 2007 NCCS set mitigation targets and acknowledged the importance of adaptation, but only referenced flooding specifically. The 2007 NCCS addressed the role of local authorities: "local authorities can have a significant influence over emissions in their local areas, both directly in relation to reducing emissions through their own energy use and procurement activities, in raising awareness and stimulating action in local communities, and indirectly through the exercise of their housing, planning and other statutory functions" (DEHLG, 2007b:36).

Second, the 2012 *Irish National Climate Change Adaptation Framework* (NCCAF) was the first national policy specifically addressing climate adaptation. The NCCAF

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[1] The Irish Department of the Environment has undergone restructuring between 2000 and 2014, with different combinations of responsibilities. Each iteration of the Department has included a remit for climate change and the environment: the Department of the Environment and Local Government (DELG); then the Department of the Environment, Heritage, and Local Government (DEHLG); and most recently the Department of Environment, Community, and Local Government (DECLG). The referencing and citations throughout this document reflect the configuration of the Department at the time the policies were published.

acknowledged the importance of proactive adaptation by all sectors at the national and local levels. According to the NCCAF, adaptation will be mainstreamed into sectoral and development plans by mid-2014. Mainstreaming is "the integration of adaptation objectives, strategies, policies, measures or operations such that they become part of the national and regional development policies, processes, and budgets at all levels and stages" (DECLG, 2012b:49). These mainstreamed actions will be designed and implemented by national government ministries and by local authorities. While lacking statutory backing, the NCCAF also requires that national departments review sectoral plans every 5 years, and local authorities to include climate adaptation within their review of local development plans every 6 years. It further acknowledges the need for adaptation indicators "to assist in monitoring and review of plans as well as allowing for comparison across plans" (DECLG, 2012b:46). While the NCCAF does not include detailed guidelines for local authorities, these will be forthcoming.

Third, the DECLG proposed a low carbon transition in its *Climate Action and Low Carbon Development Bill 2015* (DECLG, 2015), with the General Scheme first being issued in 2014 (DECLG, 2014a). This proposal acknowledges UNFCCC and EU commitments, provides for an external Expert Advisory Body, and requires the minister to submit plans to Government within 24 months and every 5 years, which plans cover implementation of the national adaptation framework. If the Bill is approved, annual reports of each Department's progress will be made to Dáil Éireann (DECLG, 2015). Regarding specific emission reduction targets in the proposed bills adhere to UNFCCC and EU targets but include no specific percentages. While not enshrined in legislation, the *National Policy Position* of the *Climate Action and Low-Carbon Development Bill,* issued with the earlier 2014 Climate Action Bill (DECLG, 2014a), defines this low-carbon transition to include an 80% CO_2 emission reduction by 2050 (for electricity, built environment and transport) and carbon neutrality in agriculture and land-use (DECLG, 2014b). These national climate policies show intent to move forward on climate change without delivering details and concrete actions.

General national policies include few mainstreamed climate change provisions. For example, the *National Spatial Strategy 2002-2020* (DELG, 2002), *Actions for Biodiversity 2011-2016: Ireland's National Biodiversity Plan* (Department of Arts, Heritage and the Gaeltacht, 2011), and *Our Sustainable Future: A Framework for Sustainable Development in Ireland 2012* (DECLG, 2012c) only included generalised links between climate change and other sectors. For example, the 2012 Sustainable Development Framework referenced climate mitigation and included very limited references to climate adaptation: a general acknowledgement of the need to adapt, specific links with biodiversity, and the need to "ensure that critical infrastructure is climate resilient" (DECLG, 2012c:51).

Similarly, national planning statutory instruments and guidelines include a very limited mention of climate change as shown by five main documents adopted between 2005 and 2010. The *Implementation of Regional Planning Guidelines: Best Practice Guidance* shows an increased recognition of climate change between 2005 and 2010[2]. While both versions require increased accountability by local planning authorities, only the 2010 version requires “the promotion of measures to reduce anthropogenic greenhouse gas emissions and address the necessity of adaptation to climate change" (DEHLG, 2010a:13). Further, it requires regional implementation groups to report annually, and city/county development plans to include core strategies for population density (DEHLG, 2010a). The 2007 *Development Plans: Guidelines for Planning Authorities* required council development plans "to be consistent with the objective of The National Climate Change Strategy 2007-2012" (DEHLG, 2007a:3); however, the Strategy includes few requirements for local authorities. The 2009 *Guidelines for Planning Authorities: The Planning System and Flood Risk Management* and *Technical Appendices* (DEHLG and Office of Public Works (OPW), 2009a and 2009b) recommended a precautionary approach for climate change impacts (rising sea level, coastal and estuarial flooding, and coastal erosion), but did not include detailed projections. Lastly, the *Planning and Development (Amendment) Act 2010* (section 10.2.n) requires local authorities to reduce emissions and address the need for climate change adaptation, but does not include specific requirements. Climate change references are included in three national planning guidelines for: flood risk management, local development plans, and regional guideline implementation. Overall, the national planning guidelines include few references to climate change. This represents a shortfall in climate measures because these guidelines set the ground rules for local development plans and individual planning decisions.

Also at the national level, semi-state and professional bodies have publicly addressed climate change: The Irish Business and Employers' Confederation (IBEC),

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[2] The *Implementing Regional Planning Guidelines: Best Practice Guidance* was first issued in 2005. These Guidelines were revised and reissued under the same name in 2010.

Forfás, and the Irish Academy of Engineering. IBEC hosted a 2011 climate change workshop for business leaders and policymakers. This workshop focused mainly on climate mitigation and included speakers from government, academia and business leaders (IBEC, 2011). The Forfás *Adaptation to Climate Change: Issues for Business Report* (Forfás, 2010) provided an extensive review of climate impacts, specific implications for business, and potential adaptation actions. For example, the implications for energy infrastructure noted storm effects on transmission networks, changing seasonal energy demands, threats to coastal power stations, potential interruptions in fuel supply, and water supply demands (Forfás, 2010). Within this report, Forfás noted that a joined up approach was used with other national agencies such as IDA Ireland, business interests such as utility providers, and policy stakeholders such as Irish Environmental Protection Agency and the UK Climate Impacts Programme (Forfás, 2010). The Irish Academy of Engineering 2009 *Ireland at Risk: Critical Infrastructure: Adaptation for Climate Change* included climate change projections and recommended adaptation for flooding and energy supply.

These national actions have identified climate change as a priority, promoted the importance of local actions, and set the groundwork for climate adaptation. In addition, the reports from other nationwide entities illustrate wider attention to the climate change issue. Even with these actions, uncertainty remains about whether this starting point will be expanded with detailed plans and actions. Given that Wilbanks and Kates (1999) advocated an integrated approach with actions at all levels, it is necessary to explore the potential for subnational government to help fill this gap.

1.2.2. Subnational government

In Ireland there has been little research about subnational climate adaptation by regional or local government. The applicable research has concerned regional level general capacities and local level actions for related issues such as sustainable development.

1.2.2.1. Regional government in Ireland

In Ireland the eight Regional Authorities, who oversee spatial planning and general development concerns, have played a limited role. Their role has been limited by "tiny staff contingents and no budget" (Boyle, 2000:742). These Regional Authorities were established in 1994, through extensive EU funding, with the intent to balance a strategic focus with local variations (Philip 1994). In practice, the Regional Authorities have had relatively little power, and their main role was to monitor the ways in which EU Structural Funds were spent (Boyle, 2000).

Regional government in Ireland is fragmented and changing. The eight Regional Authorities share the administrative territories with other sectoral entities at the regional level: there are ten Waste Management Districts, and eight River Basin Management Districts. In 2012 national government further disturbed the regional level by amalgamating the eight existing Regional Authorities into three standard regions for the country (DECLG, 2012d). This shift may improve the Regional Authorities' potential to contribute to meaningful actions since other European countries have meaningful subnational actions. In addition, a meaningful tier of regional government can provide an expertise base for local authorities, which reduces the need for each local authority to have extensive climate change knowledge and expertise (Huang 1997). Until Regional Authorities demonstrate increased potential, subnational support for climate measures will largely fall on local government in Ireland.

1.2.2.2. Local government in Ireland

Little is known about how much local authorities are preparing for climate change. One desktop study of six local development plans suggested that Irish local authorities are reacting to climate-related events such as flooding, and their policies include few measures for climate change (Flood and Ní Chiardubháin, 2008).

Further, local progress has been limited for sustainable development, social inclusion, and governance networks. With regard to sustainable development, the local governance has been hindered due to passive citizen participation and the advisory capacity of City and County Development Boards[3] (Mullally et al., 2009). Governance networks for social inclusion have had weak links with local government and have not resulted in substantial policy changes (Walsh, 2001). Similar governance shortfalls have also applied to actors in the private sector. "None of the networks in Limerick involve decision-making, steering, negotiation or coordination of activities resulting in changed

[3] City and County Development Boards were comprised of "the local government sector, the local development sector (e.g. LEADER II, ADM supported partnerships and community groups etc.), state agencies and the social partners" (Mullally et al., 2009:1). The City and County Development Boards were replaced with Local Community Development Committees in June 2014.

behaviours of actors in the ICTS sector in the region" (Parker, 2007:125). Although the published literature shows a lack of progress, added research is needed to discover whether actions are being taken with regard to climate change, and to explore the factors affecting these actions.

1.3. Research aims

Even with available climate change information, there is limited knowledge about Ireland's climate change preparations. Further, existing Irish research does not consider the governance factors that affect those preparations. More striking is the lack of information about how government staff members perceive their role in addressing climate change. This thesis represents the first significant piece of research on Irish local authorities' preparations for climate change. Therefore, this research aims:

1) to assess the ways that climate change will affect Irish local authorities, with a specific focus on exposures and impacts for sectors under their remit. The lack of information whether their areas are at greater risk than others leaves local authorities in the position of responding to crises as they occur rather than preparing for the future;

2) to assess factors that affect adaptation by local authorities. The limited research on relevant local authority actions raises the question of whether barriers are inhibiting actions on climate change, governance and environmental protection. Without a greater understanding about barriers and potential solutions, improved local authority preparations are unlikely. Alternatively, a greater understanding about ways to facilitate local authority actions will provide opportunities for national government to achieve its stated goals and to protect people and the environment.

1.4. Overview of thesis structure

Chapter 2 reviews the literature regarding climate change vulnerability and government climate change adaptation. Irish climate change research has been limited to impact assessments and localised studies. This leaves ample scope to expand knowledge about Irish climate change vulnerability, and this chapter reviews the international literature and advises questions about how to expand good practice here. The first part traces the evolution of climate change vulnerability. The second part explores government's adaptive capacity. The chapter concludes with an introduction of the research objectives.

Chapter 3 describes the two strand methodology used to assess climate change vulnerability and assess the factors that affect adaptation by local authorities. The first research strand assessed climate change vulnerability, and the second strand explored adaptive capacity of Irish local authorities. Within the first research strand, available datasets used to assess climate change vulnerability and responses to climate change in Ireland. Assessing climate change vulnerability requires consideration of exposure, sensitivity, impacts, and adaptive capacity. The assessment used available datasets for climate change projections, recorded events, land attributes, policies and resources. Any datasets which were incomplete or not fit for purpose were supplemented with data created through the current research.

Chapter 4 provides the results from the development plan review. These results provide information about the current state of actions by local authorities and their mainstreaming of climate change into their main strategy document, the development plan. Consideration for the number, type, and distribution of measures is included.

Chapter 5 provides the results of the baseline climate change vulnerability assessment of issues which included physical exposures, impacts and adaptive capacity to be addressed by Irish local authorities. The assessment showed how climate change vulnerability varies at the county level in Ireland.

Chapter 6 provides the results of the two surveys of all Irish local authorities. These surveys focused on 1) local authority perceptions regarding climate change, 2) policies and measures in place to address climate change, and 3) the most common barriers faced by local authorities with regard to taking action on climate change. The surveys provided information about the level and types of actions, but questions remained about the drivers for climate change actions.

Chapter 7 provides results from the case studies and interviews with higher level government senior officials. The purpose of this chapter is to provide an in-depth examination of local adaptation based on case studies of four local authorities. This chapter also places the local experience within the wider national context through higher level interviews.

Chapter 8 discusses the findings from each research strand, discusses the relevance of governance theory and the subsidiarity principle, and evaluates the merits of the methodology used. It also discusses the lessons learned about the climate change challenge that may also apply to other environmental issues. The contributions to knowledge are identified as well as recommendations for future research.

Lastly, Chapter 9 provides recommendations for governments of short actionable measures. These measures include necessary actions for each level of government to build capacity and monitor progress as well as actions that will improve integration.

Chapter 2. Literature Review

2.1. Introduction

This chapter explores the literature about how we understand climate change vulnerability and how governance theory can help explain governmental preparations for climate change. Regarding climate change vulnerability in the Irish context, climate change research has been limited to impact assessments and localised studies. Impact assessments have been prepared at national level for climate change (Dunne et al., 2008; Sweeney et al., 2008), landslides (Creighton, 2006; Dixon and Brook, 2007), and biodiversity (Coll et al, 2012). In addition, a national level scoping exercise showed that some sectors were more vulnerable to climate change than others (Coll and Sweeney, 2012). There has also been some examination of coastal vulnerability (Devoy, 2008; McLaughlin and Cooper, 2010). Therefore, there is the need to expand knowledge about climate vulnerability in Ireland and this chapter reviews the international literature with a view towards developing good practice in Ireland.

Regarding governance and preparations for climate change in the Irish context, studies have shown weak governance structures in terms of networks within Ireland (Walsh, 2001; Parker, 2007) and among Irish entities and other international actors (Davies, 2005). These existing studies lack information about the particulars of climate change adaptation, and further information is needed about the interactions between the different levels of government.

More generally in order to evaluate how climate change will affect Ireland, clarity is needed about how the terms are defined and what is included and excluded. The understanding of how to address climate change has been evolving over time with shifts in focus and definitions of key terms. While the focus over time has included both the physical climate and human factors, the emphasis has expanded from quantifying the physical trends to include socio-economic and administrative factors. The first part of this chapter develops the concept of vulnerability and its application to climate change. The second part of the chapter explores governance including government's capacity, expressed and potential, to adapt to climate change.

2.2. Vulnerability and Risk: Approaches and Assessments

Vulnerability studies draw on research from natural hazards, social vulnerability and combined climate vulnerability approaches (Cutter, 1996; Adger 2006; Füssel, 2007; Preston et al., 2011). As a brief introduction to these research areas, physical vulnerability research draws on natural hazards research which prioritises external stressors such as floods, and responses by natural systems and/or society. Social vulnerability is an alternative approach that focuses on entitlements and socio-political factors as described later. Lastly, more recent research has focused on climate change with a combined approach that addresses the physical and some of the socio-political factors of vulnerability and risk. Each of these research traditions is relevant to this study of Irish local authorities and climate change because, without considering both the physical and social vulnerability, local authorities will be ill-prepared to protect the people and environment in their areas.

More generally, the primary focus (from the mid-20th century and continuing until the present) has been on minimising harm to people and natural systems. As the following sections show, the terminologies and nuanced approaches have evolved and are continuing to change. Most recently, there was a change in how vulnerability was defined when comparing the Intergovernmental Panel on Climate Change (IPCC)'s *Fourth Assessment Report* in 2007 (AR4) and the *Fifth Assessment Report* in 2014 (AR5). There are similarities and differences between the two approaches: both iterations focus on the overlap between physical and socio-economic factors, but the terminology for this overlap has changed as will be discussed in 2.2.3. Included here as a frame of reference, the AR4 defined the intersection of these factors as vulnerability:

> Vulnerability is the degree to which a system [physical, human, societal] is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.
>
> (Parry et al., 2007:883)

The more recent AR5 defined the intersections of these factors as risk:

> a product of the complex interaction between physical hazards associated with climate change and climate variability on the one hand, and the vulnerability of a society or a socio-ecological system and its exposure to climate-related hazards on the other.
>
> (Oppenheimer et al., 2014:7)

Again, the overall concern to reduce harm associated with climate change is maintained, and the individual factors are further developed. The change in definitions is a useful reference point for the following path through the evolution of vulnerability, hazards and risk studies. These diverse research traditions represent an ongoing debate about environmental and social concerns and, more recently, have been applied to climate change. The natural hazards tradition and social vulnerability studies provide the building blocks of how climate change is understood and studied.

2.2.1. Natural hazards

Natural hazards research predates climate change research. It began in the mid-20th century (White, 1945). This research tradition considered physical events and conditions that were harmful to people (Burton and Kates, 1964). Early studies focused on external stressors, such as floods, and sought to increase knowledge about the nature of physical events and potential responses. For example, repeated large-scale floods between 1874 and 1936 prompted the United States government to fund research on reducing flood hazards and to adopt the Flood Control Act of 1936. In addition to improving knowledge about the physical parameters, the researchers concluded that existing approaches, based on engineering, public welfare and meteorology, were inadequate (White, 1945). Therefore, there was a need for an expanded approach to improve responses by government and private actors.

This early work addressed internal and external factors affecting responses. White acknowledged that external factors prevented full implementation of potential responses. These external factors included data limitations, strong stakeholder opposition, and lack of precedent (White, 1945). Conversely, Saarinen focused on internal factors in his studies of the 1930s' dust bowl conditions. Farmers facing similar drought conditions perceive hazards differently depending on their most recent direct experience and on their accumulated experience (Saarinen, 1966). Likewise, natural resource managers perceive hazards such as floods, coastal protection and earthquakes differently depending on how relevant the hazard is to their specific area, how frequently the hazard occurs, and the individual's personal experience (Burton and Kates, 1964).

Overall, most research between 1945 and the 1970s focused on quantifying natural hazard events such as earthquakes, and devising technological fixes (White and

Haas, 1975). This focus neglected White's earlier call for a more comprehensive, integrated approach that included a full range of adjustments and participation by public and private entities (White, 1945). Following on from White's research, by 1975 there was a growing recognition that human responses were equally important when the effects of natural events on people were considered, as illustrated by Figure 2.1 below:

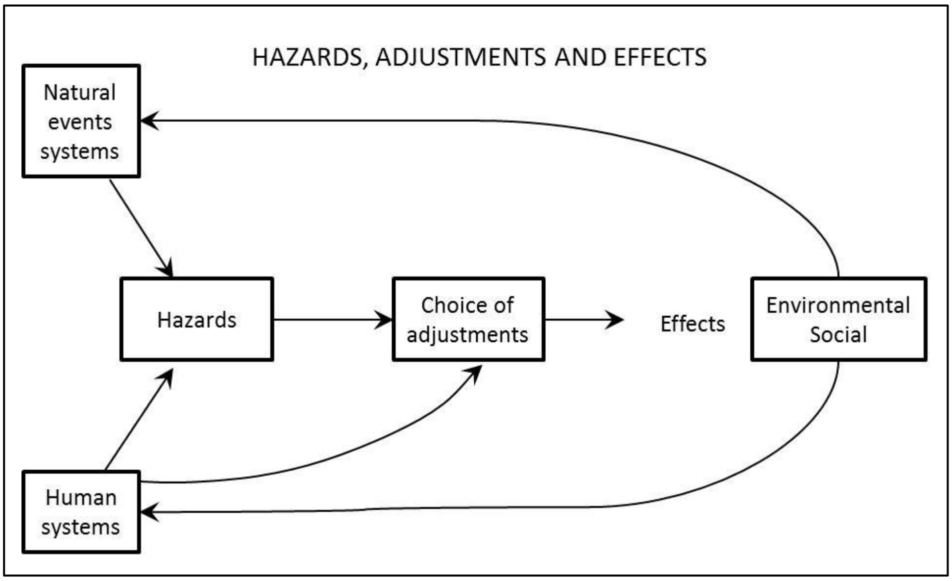


Figure 2.1 Interactions between natural and human systems (White and Haas, 1975)

Factoring human systems into the natural hazards approach, along with the physical impacts themselves, showed that adjusting to natural hazards is an iterative process. At this point, a partially integrated approach gained prominence, which used 'hazards' and 'effects' as umbrella terms. At this early stage, there was limited understanding about human responses to hazardous events (Hewitt and Burton, 1971). Responses were defined as adaptation ("long-term arrangement of activity to take account of the threat of natural extremes") and adjustment ("all those intentional actions which are taken to cope with the risk and uncertainty of natural events") (White and Haas, 1975:57).

Assessments, based on the natural hazards approach, evaluate the spatial distribution of physical characteristics and events, but only show part of the picture because they do not extend to how human systems are affected. This applies whether the assessment is local or global. Local coastal vulnerability assessments in the United States compare variations within a small stretch of coastline, but do not include adaptations to these variations (see Figure 2.2) (Pendleton et al., 2004). Similarly, landslide vulnerability due to landscape characteristics, such as slope, varies even within individual counties such as Travis, Texas (Wachal and Hudak, 2000). Global environmental vulnerability varies among nations being compared based on factors such as earthquakes, high winds, and endangered species (Kaly et al., 2004). As Kaly et al. (2004) showed, even when the global Environmental Vulnerability Index does consider human-related factors, it includes mining, conflicts and pesticide use rather than adjustments or adaptations. While this example does not fit neatly into the physical vulnerability category, it shows a continuing research tradition to prioritise external factors rather than seeking transformational measures. Within environmental hazards research, the impacts of these factors are analysed in the context of how the physical environment is affected. It still does not extend to how human systems are affected. The information provided by these assessments has limitations because of this. Additionally, vulnerability is treated as an endpoint condition without consideration of whether adaptations occur (Adger and Kelly, 1999).

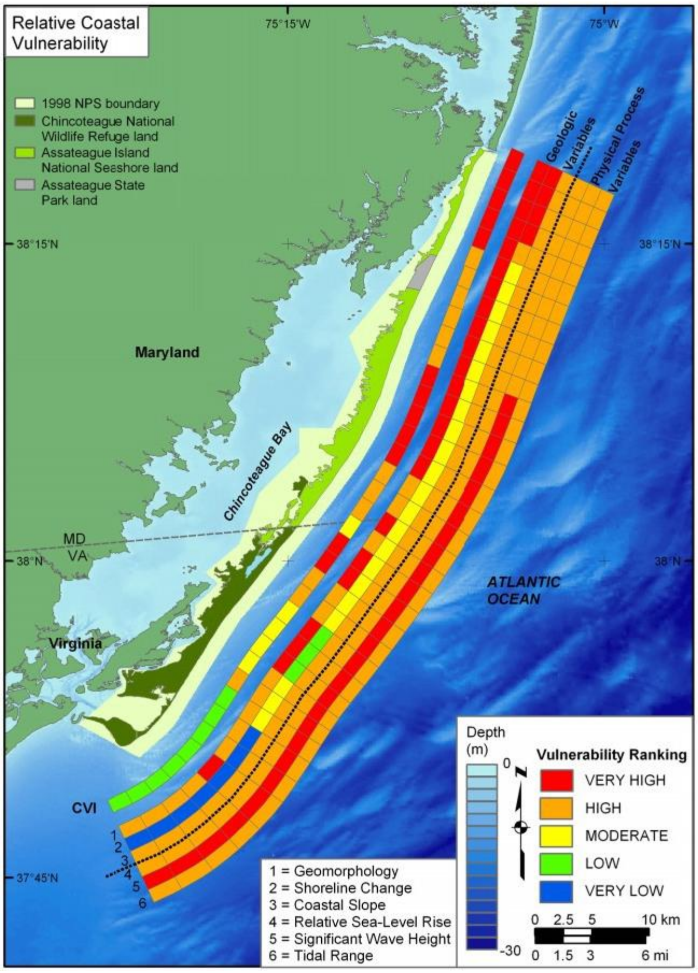


Figure 2.2 Coastal vulnerability and contributing variables (Pendleton et al., 2004)

Other criticisms of the natural hazards approach are more far-reaching. The basic premise of external stressors as the primary focus has been called into question as noted in the updated *The Environment as Hazard* (Burton et al., 1993). The key criticisms are two-fold: disasters do not show the full vulnerability picture and higher-level driving forces are not considered. First, natural hazards research, with its focus on disasters, does not capture the day-to-day challenges people face such as access to water in developing countries. Second, higher level driving forces or large-scale transformational trends need to be considered by including socio-economic factors. As Burton et al. (1993) note, the issues regarding the types of disasters have been addressed to a degree because researchers have begun to examine slow change types of stressors such as climate change and desertification. Even so, this research thread maintains the bias that vulnerability is determined by the external stressors.

These factors alone fall short of explaining vulnerability as it relates to people (Wisner et al., 1994, 2004; Adger, 2006). Even with these limitations, an understanding of the physical environment and related changes is needed if governments are to address challenges. This shortfall is answered, in part, through the parallel strand of research that focuses on social vulnerability as discussed in the next section.

2.2.2. Social vulnerability

Social vulnerability research proposes a very different set of explanations about vulnerability and its causes. The social vulnerability approach is based on Sen's (1981) argument that vulnerability, as in the case of famine, results from inadequate responses rather than external stressors. Some individuals and groups are less able to meet their basic needs because of "the legal, political, economic and social characteristics of the society in question and the person's position in it" (Sen, 1981:46). Using this framework, Wisner et al. (1994, 2004) defined vulnerability to natural hazards based on the human factors of root causes, dynamic pressures and unsafe conditions.

Social vulnerability assessments evaluate how personal characteristics and individual circumstances (e.g., personal wealth, age, density of built environment, and ethnicity) affect the spatial distribution of vulnerability (Kelly and Adger, 2000; Pandey and Jha, 2012). Some recent assessments have evaluated how vulnerability varies within a given area at different scales: sub-national regions, national, and for a continent. Vulnerability varies within sub-national regions as in the case of Srinagar, Uttrakhand, India (Pandey and Jha, 2012) or coastal Vietnam (Kelly and Adger, 2000), within a nation such as the United States as shown in Figure 2.3 (Cutter et al., 2003), or within a continent such as Africa (Vincent, 2004). Based on an examination of the socio-economic factors (e.g. age, housing stock and tenancy, and infrastructure dependence) for US counties, Cutter et al. (2003) concluded that each county's social vulnerability varied from adjacent counties' social vulnerability for contributing factors and overall level of social vulnerability. The assessments, framed at the county scale, "can assist local decisionmakers in pinpointing those factors that threaten the sustainability and stability of the county (or community)" (Cutter et al., 2003:258).

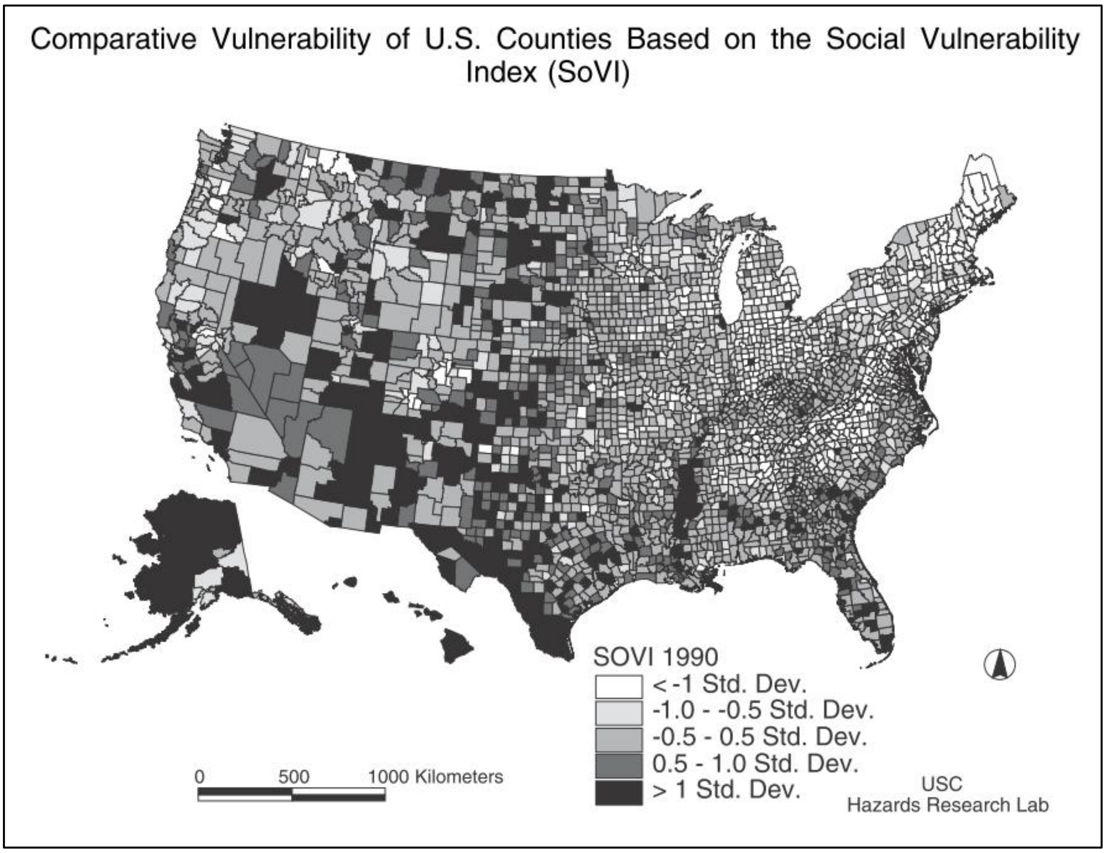


Figure 2.3 Subnational assessment of social vulnerability (Cutter et al., 2003)

The personal characteristics and individual circumstances fall short of explaining vulnerability in the context of external stressors. At the same time, excluding these factors from consideration provides an incomplete picture because vulnerability is about the effects on people as well as the environment. Therefore, a combined approach is needed to better assess vulnerability.

2.2.3. Climate change vulnerability and risk theory

As stated earlier, the theories and studies of climate change vulnerability and risk have evolved to encompass concern for the physical factors as well as socio-economic factors. In the 1990s and the 2000s, the overarching term was vulnerability. Later in the mid-2010s, the overarching term was risk. These changing terms present challenges for researchers and policymakers alike, as noted by researchers who have carried out climate vulnerability assessments (section 2.2.4). Clarity about the definitions provides a strong grounding for the application of the concepts to the Irish context.

2.2.3.1. Climate change vulnerability theory

As part of a rising awareness of climate change, Burton et al. (2002) called for a broader research paradigm with a shift from impact assessment to vulnerability assessments that included adaptive capacity. This resulted in shifting definitions in two ways: a) from hazards to a more nuanced approach (impacts, exposure, and sensitivity), and b) from social vulnerability to adaptive capacity.

Climate vulnerability researchers redefined the previous hazards or extreme events as impacts which are determined by exposure and sensitivity. Impacts are the "consequences of climate change on natural and human systems" (McCarthy et al., 2001:989). Examples include "flooding, landslides, mudslides and avalanches driven by projected increases in rainfall intensity and sea-level rise" (White, K.S. et al., 2001:38). Within the three broad approaches (of natural hazards, social vulnerability, and climate change vulnerability), exposures were evaluated differently. In natural hazards research, exposures were evaluated as 'natural events systems' (Burton et al., 1993:243). In social vulnerability research, exposures were evaluated as the climatic part of 'hazards' under the pressure and release model which prioritises social vulnerability (Wisner et al., 1994, 2004). In climate change vulnerability research, exposure is evaluated and defined as "the nature and degree to which a system is exposed to significant climatic variations" (McCarthy et al., 2001:987). Examples of exposure include "single climate variables (such as local temperature), specific weather events (such as a convective storm), and long-term processes (such as anthropogenic climate change)" (Füssel and Klein, 2006:313). Sensitivity, the other factor that determines impacts, is "the degree to which a system is affected" directly (e.g. changing crop yields) or indirectly (e.g. flood related damages) (White, K.S. et al., 2001:21). Impacts (the combination of exposure and sensitivity) are the most pressing concern for adaptation because decision-makers and individuals are seeking to minimise harm.

Within climate change vulnerability research, responses were re-defined as well. As stated earlier, natural hazards research defined responses as adjustments or adaptations. Climate change vulnerability research used adaptation as a collective term that merged adjustments and adaptation as well as encompassing adaptive capacity as a necessary component for adaptation. Adaptive capacity aligns with the social vulnerability research in that it considers the characteristics and situation of the actor.

Adaptive capacity is the "ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (Parry et al., 2007: 869). Adaptive capacity is evolving and affected by external influences that include broad scale determinants (e.g. general socio-economic and political systems) as well as local scale determinants (e.g. the institutional environment and political influence) as shown in Figure 2.4 (Smit and Wandel, 2006).

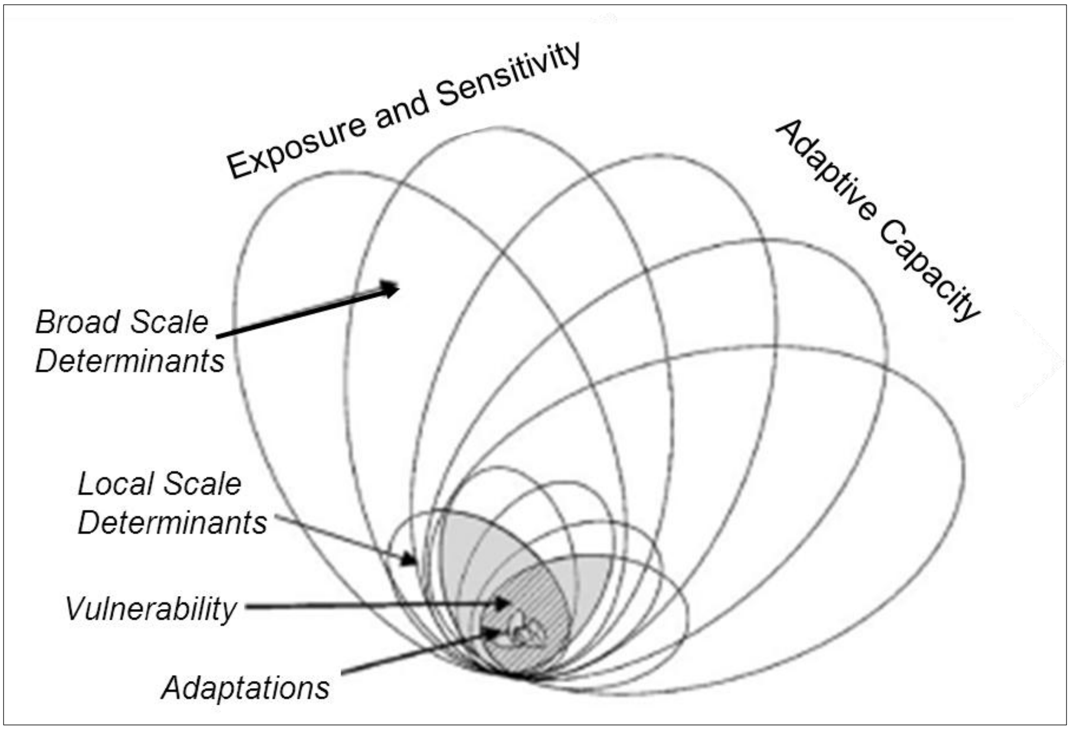


Figure 2.4 Nested hierarchy model of vulnerability (Smit and Wandel, 2006)

Adaptive capacity is an evolving condition, which can be increased through indirect or direct experiences. For indirect experiences, network members learn through sharing information, and individuals in organisations learn through informal knowledge transfers (Pelling et al., 2008). For direct experiences, extreme events prompt people to mobilise resources and, thereby, increase their adaptive capacity. For example, the 2003 heat waves (an extreme event – E_1 in Figure 2.5) challenged governments to expand their adaptive capacity (shown as the coping range in Figure 2.5). In response to the heat waves, the UK took action at national and local levels. Nationally, the UK Public Health England established a Heat-Health Watch alert system, set recommendations for service providers, identified impacts for other sectors, and set procedures for engaging with the community (UK National Health Service, 2004; Public Health England, 2014). Locally, London plans to work with partners to increase green infrastructure and encourage improved housing standards as well as adhering to the National Heatwave Plan (London Climate Change Partnership, 2006; Greater London Authority, 2011).

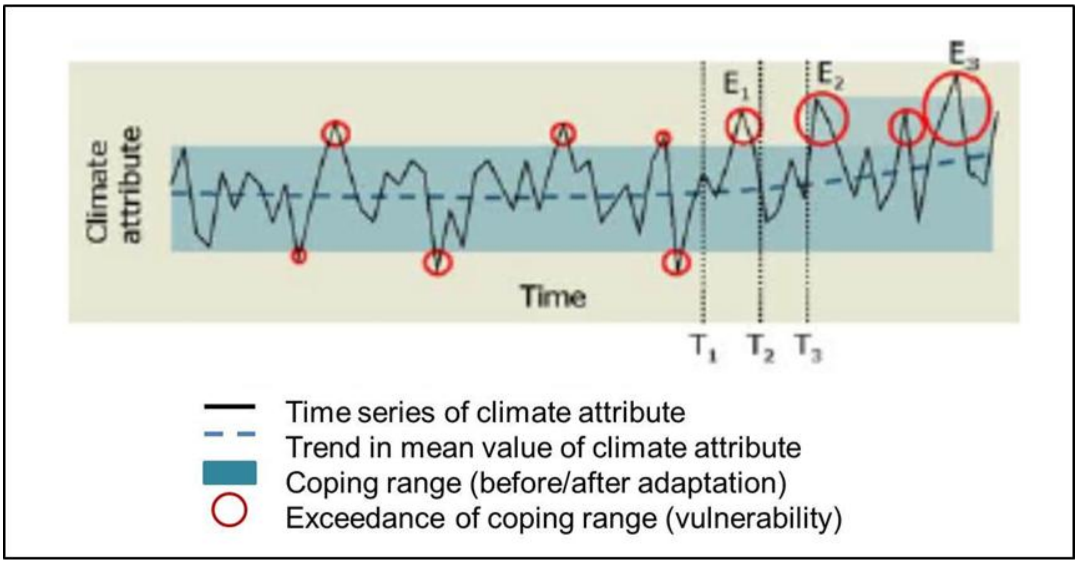


Figure 2.5 Adaptation timeline showing increased coping range (Füssel, 2007)

Adaptive capacity is evidenced through adaptation, i.e. specific actions to address these events and changing conditions or trends. Adaptation is defined as "adjustments in ecological-social-economic systems in response to actual or expected climatic stimuli, their effects or impacts" (Smit et al., 1999:200). Adaptation actions include building capacity and implementing adaptation decisions (Adger et al., 2005). People build capacity, individually and/or in groups, by increasing information and improving their general capacity (Adger et al., 2005). Implementing adaptation decisions involves acting to address the effects of climate change, e.g. changing insurance coverage and redesigning infrastructure such as irrigation systems and bridges

(Schneider and Sarukhan, 2001). Information is needed about adaptive capacity and adaptations for governments to move forward on climate change. Without this information, each local authority will be left to gain understanding and build capacity.

Adaptation actions are taken by individuals, groups and governments (Adger et al., 2005). While adaptation requires an integrated approach which merges local and national actions (Wilbanks, 2007), the following are some illustrative examples at each level. Individuals adapt in many ways such as retrofitting properties, preparing for floods, and changing farming practices. A youth hostel in the UK retrofitted its internal heating and water systems (Tompkins et al., 2010). German property owners prepared for floods by learning more about flood protection, changing furnishings and purchasing protection devices (Grothmann and Reusswig, 2006). Rural householders in Nigeria changed their farming practices to adapt to drought conditions, e.g. diversifying their crops and livestock (Dabi et al., 2009).

Groups adapt through collective action in response to food scarcity, water shortages and threats to coastal environments. For example, community groups in the Inuit community deal with food scarcity by adapting their hunting behaviour and by cooperating through inter-household networks (Ford, 2009). Non-governmental organizations such as Oxfam help people at the local level directly and globally by raising the profile of climate change, e.g. participating in world conferences. Oxfam helped alpaca herders in Peru to restore water infrastructure, to diversify their crops, and to build sheds for livestock protection (Orlove, 2009). People in Vietnam came together informally to protect their coast when the government collapsed during the 1990s (Adger, 2003). Governments are the other actors that adapt. They are a key actor because many adaptations, such as addressing large-scale floods, are beyond the scope of an individual property owner. This research is focused on government actors and examples will be detailed in section 2.3.

Overall, climate vulnerability is determined by the combination of impacts, adaptive capacity, and adaptations. Vulnerability is an evolving condition which requires an iterative assessment process that incorporates current and evolving knowledge, circumstances and capacities (Füssel and Klein, 2006; European Environment Agency (EEA), 2008), as shown in Figure 2.6.

In Figure 2.6, the left side relates to the physical exposures and impacts, and the right side relates to the socio-economic factors. When these two factors combine, vulnerability results. Further, the effects of adaptation on vulnerability are included at the bottom. Overall, relationship between the factors and vulnerability are shown.

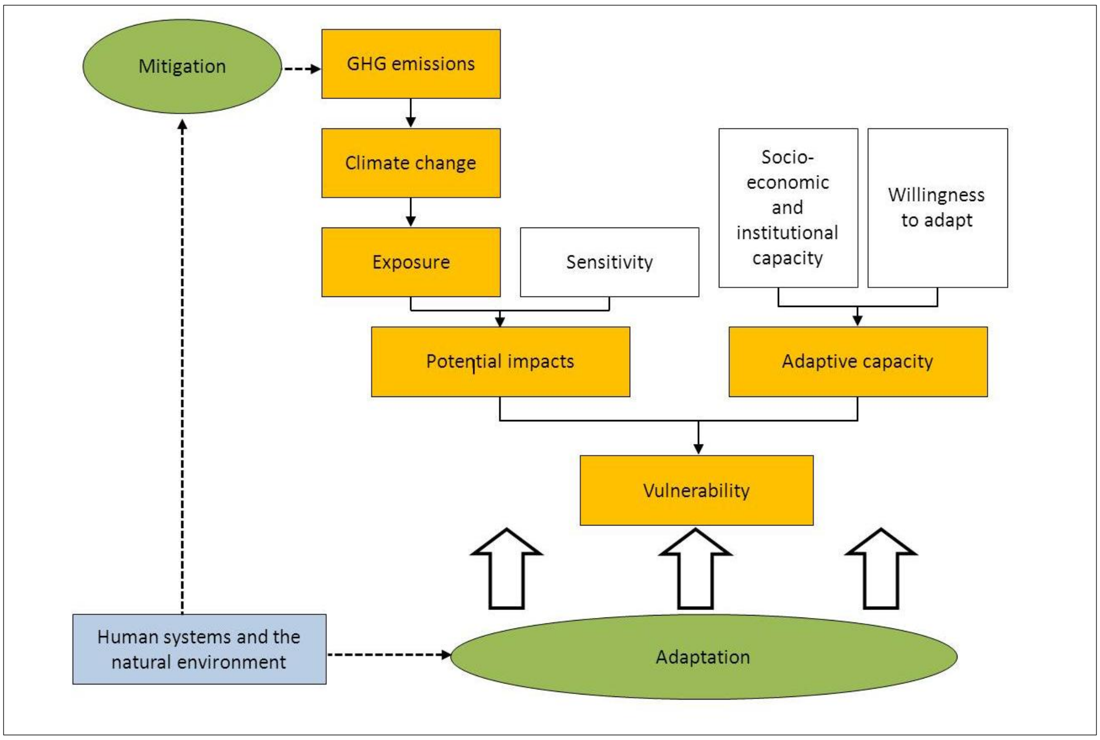


Figure 2.6 Conceptual model for impacts, vulnerability and adaptation (EEA, 2008)

As with any model, the framework gives an overview to promote understanding but oversimplifies the complexities. For example, the uncertainty regarding potential impacts is underrepresented, e.g. exposure resulting from climate change. Similarly, the challenge is underrepresented for transforming general capacity into adaptive capacity for climate change. All these factors will need to be considered when examining how local authorities can prepare for climate change. This climate change vulnerability approach and related definitions have been adopted by the EEA. Even so, the understanding of how to address climate change is still evolving. This presents challenges for policymakers because changing terminology suggests raises questions about which factors need to be considered. A closer examination of the evolving paradigms shows more similarities than differences.

2.2.3.2. Climate change risk theory

The evolving framework, from climate change vulnerability in the IPCC AR4 to climate change risk theory in the IPCC AR5, maintains a focus on combined harm of climate change and people-related factors. These approaches, drawn from different perspectives, present challenges for policymakers due to "difficulties in comparisons. For instance, findings that are described as vulnerabilities in some studies may be classified as impacts in others; lack of adaptive capacity in one setting might be described as social vulnerability in another" (Hewitson et al., 2014:9).

In the previous paradigm, combined harm was defined as vulnerability (the combination of impacts and adaptive capacity). In the new paradigm, combined harm is defined as risk (the combination of hazards, vulnerability, and exposure) (Figure 2.7).

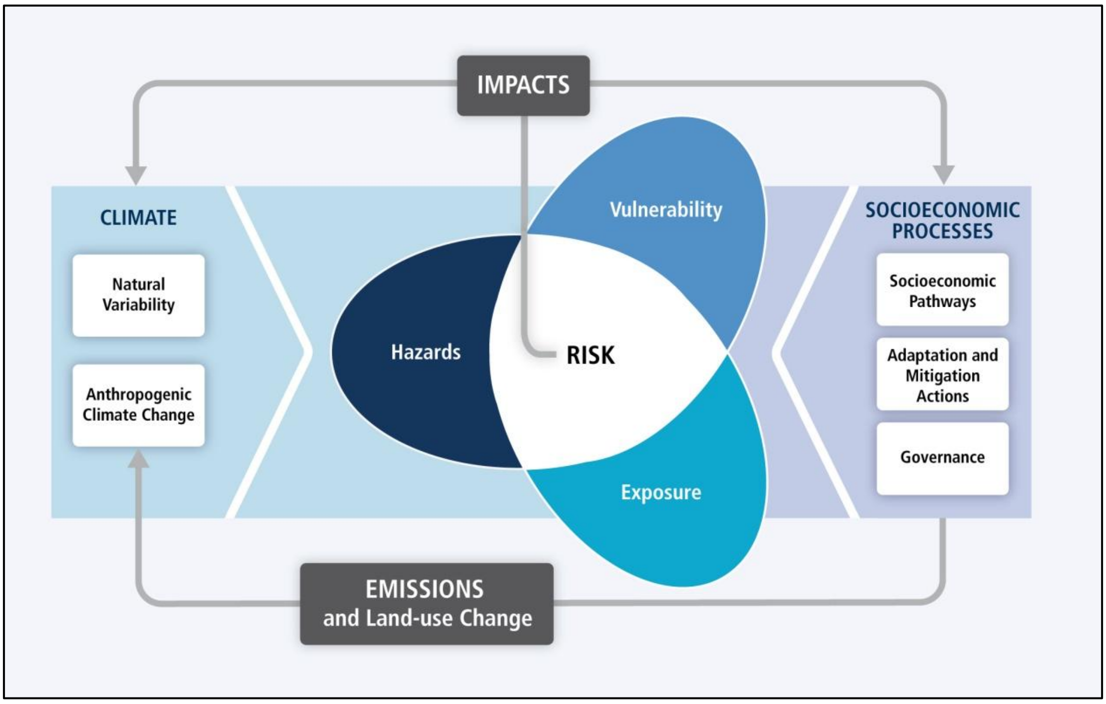


Figure 2.7 Climate change risk schematic (IPCC, 2014)

Breaking this down further, hazards are the combined effects of natural variability and anthropogenic climate change. This is closely aligned with climate change drivers under the previous paradigm. Also in the new paradigm, vulnerability and exposure result from the combination of climate change and socio-economic processes. These shifts represent an increased focus on socio-economic processes (socioeconomic pathways, adaptation and mitigation actions, and governance). The last point of governance is very important to the current study because it helps to explain the drivers for actions. Under the previous paradigm, governance was an implicit part of capacity. Under the new paradigm, governance is included as an explicit factor for climate actions.

2.2.4. Climate change vulnerability and risk assessments

Moving from a theoretical focus to an operational focus, this section considers how the climate change effects are assessed. These assessments provide information to policymakers and facilitate climate change discussions (Yuen et al., 2012). Climate change assessments evaluate the potential for harm for specific areas. Some are called climate change vulnerability assessments, and others are called climate change risk assessments. These assessments highlight areas with exposure or risk or vulnerability.

The underlying concepts are illustrated in Figure 2.8 below with the horizontal axis (columns) addressing natural (akin to natural hazards and physical vulnerability) and societal vulnerability (akin to social vulnerability), and the vertical axis (rows) addressing responses (akin to adaptive capacity). An actor towards the left on the horizontal axis has relatively less exposure when compared to other actors. Conversely, an actor on the right of the horizontal axis has relatively greater exposure when compared to other actors. Combining the two axes (physical processes on the horizontal axis and adaptations on the vertical axis) illustrates each actor's relative vulnerability. For example, the actor who has taken few actions (low for climate measures and adaptation) and has very low physical exposure is still vulnerable. The actor may have less to deal with regarding climate change, yet be unprepared to deal with the things that do occur.

Response: institutional capacity	Impact: natural and socio-economic vulnerability		
	Low natural and societal vulnerability	Low natural or societal vulnerability	High natural and societal vulnerability
High for climate measures and adaptation	**Low risk**		
High for climate measures or adaptation		**Moderate risk**	
Low for climate measures and adaptation			**High risk**

Figure 2.8 Municipalities' climate change risk matrix (Aall and Norland, 2005)

Most climate change assessments are limited in scope to a specific sector. Some examples have focused on sub-national coastal vulnerability (Clark et al., 1998;

Szlafsztein and Sterr, 2007; McLaughlin and Cooper, 2010), flooding (Wu et al., 2002), water poverty (Sullivan et al., 2003), agriculture (O'Brien et al., 2006), an untested methodology for climate change (Sullivan and Meigh, 2005) and environmental sustainability (Kaly et al., 2004). Even in cases where both natural and social variables are assessed, the methodology and outputs vary. Some researchers (e.g., Cutter, 1996; Clark et al., 1998; Aall and Norland, 2005) advocate a combined approach because vulnerability of a given place is determined by the combination of physical and social vulnerability. For example, coastal communities are vulnerable to extreme storms as shown in Figure 2.9, especially in areas where high physical exposures overlap with limited coping ability (Clark et al., 1998).

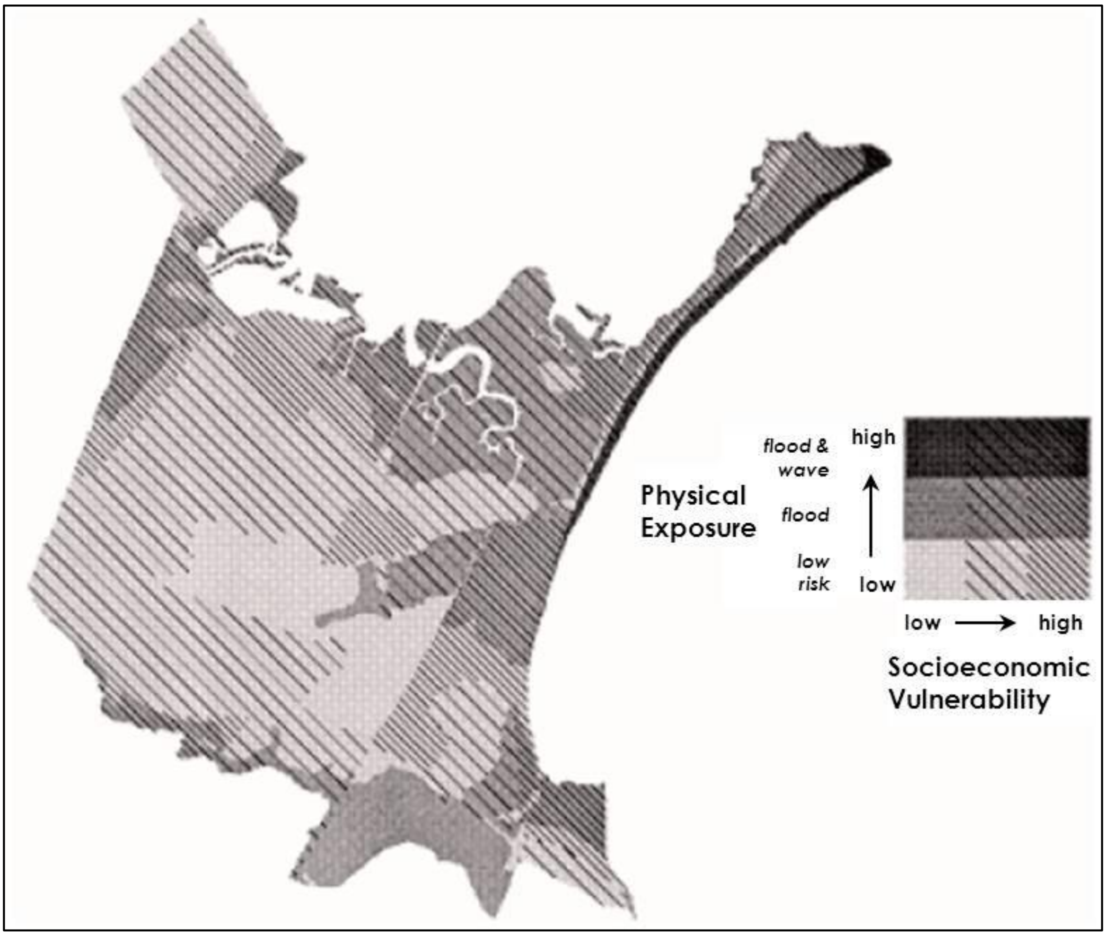


Figure 2.9 Coastal vulnerability in Revere, MA, USA (Clark et al., 1998)

Other researchers, such as O'Brien et al. (2006), present physical variables separate from socio-economic variables as shown in Figure 2.10 below. Both examples evaluate vulnerability for one sector or one impact. This means that the same locality will need multiple assessments for different impacts in order to fully prepare for climate change.

While these assessments give information about sectoral concerns, local governments are still not provided with a holistic assessment of how climate change will affect their local areas. This encourages a continued fragmented approach to dealing with climate change. Again, there is a need for an integrated approach to climate change that these assessments are not supporting.

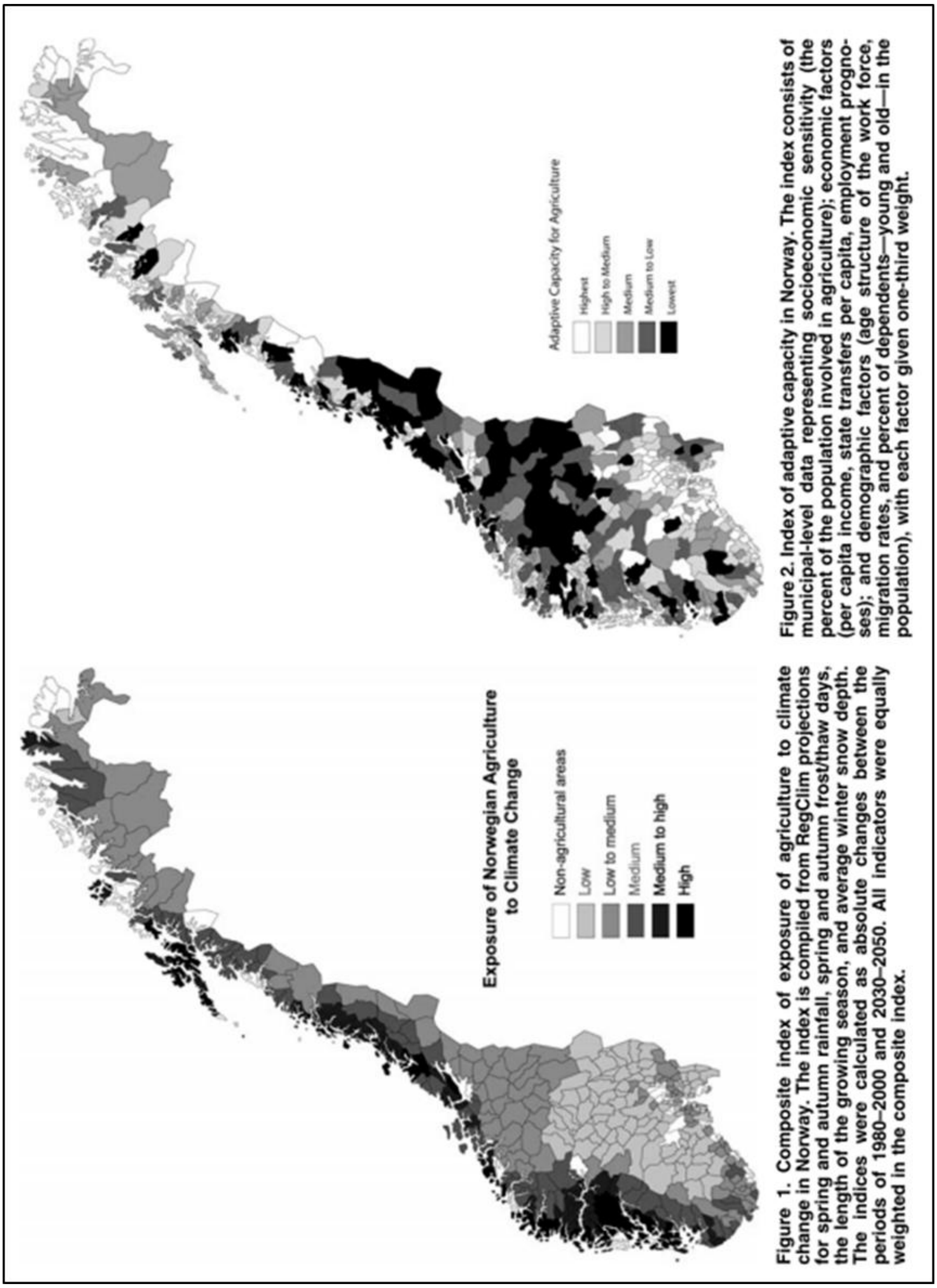


Figure 2.10 Physical exposure and adaptive capacity in Norway (O'Brien et al., 2006)

2.2.5. Critiques of vulnerability and risk assessments

While vulnerability assessments provide information, researchers differ on how much useful information a vulnerability assessment can provide. Indicators provide the means to generalise information but they have recognised limitations related to definitions, lack of a standardised approach, concerns about variations within the study area, and appropriateness for vulnerability.

Because researchers do not agree on the definition of 'vulnerability', the design and results will vary depending on whether physical, social or combined vulnerability is being assessed (Preston et al., 2011). Definitions and thresholds need to be clearly defined (Adger, 2006) in theoretical discussions (e.g. Brooks et. al., 2005; Cutter, 1996; Cutter et al., 2003) and vulnerability assessments (e.g. physical: Pendleton et al., 2004; social: Pandey and Jha, 2012; for specific sectors: Clark et al., 1998; O'Brien et al., 2006). Without explicit definitions, the outcomes of vulnerability assessments are prone to misinterpretation (Preston et al., 2011).

Lack of standardised approaches for vulnerability limit the transferability of assessment methodologies to different contexts. Similarly, thresholds can be problematic because researchers define the threshold when conducting a vulnerability assessment (Eriksen and Kelly, 2007). In the absence of standardised guidelines, the metric used to characterise a portion of the population as highly vulnerable versus low vulnerability will be determined by both the other sections of the population and by the thresholds or breakpoints for the vulnerability categories. Therefore, as in the case of the O'Brien et al. (2006) study, a subset of the Norwegian population with high vulnerability in a national context, yet less vulnerable in a global context where their vulnerability may be less than people in coastal Vietnam (Kelly and Adger, 2000).

Similarly, methodologies that suit one location may not be transferrable to other places (Birkmann, 2007). For example, The Americas Project compared the relative vulnerability of 12 countries in Latin America and the Caribbean. This methodology would not be directly transferrable to developed countries because of different circumstances and concerns, e.g. social pensions. In developing countries where pensions are not widespread and there is a young population, increasing social pensions suggest increasing resilience. Conversely, in developed countries where pensions are prevalent and there is an ageing population, increased social pensions would place added demands and stresses on budgets, health care provisions, and pension systems (Birkmann, 2007). Therefore, it is very important that each assessment's framework and limitations are made transparent (Eriksen and Kelly, 2007).

Vulnerability assessments may miss variations within the study area depending on the scale of the assessment where different variations will be highlighted. For example, national level assessments do not provide information about subnational variations (Aall and Norland, 2005; Adger, 2006; Eriksen and Kelly, 2007). This is also problematic because these assessments fail to engage with local actors and, therefore, this limits ownership at the local level – where the policies are actually implemented (Aall and Norland, 2005). Similarly, even when vulnerability is assessed at a given level for a particular place, there may be differences depending on individual actions (Adger, 2006). For example, if a farmer has acted to reduce his vulnerability, he may be less vulnerable than a property owner who has not taken proactive measures (Adger, 2006). This would also be the case where individuals within a population will have different levels of available resources. Therefore, ranking a population as vulnerable gives some information about the overall challenges facing that population, but does not address the varied severity of vulnerability experienced by different members of the population. Therefore, to fully evaluate the vulnerability of a given population, it is necessary to consider the nuances within the study area.

Some researchers argue that indicators have limited usefulness in capturing vulnerability related to the evolving nature of vulnerability. First, vulnerability assessments provide an incomplete understanding of the root causes and driving forces of vulnerability (Adger, 2006; Birkmann, 2007; Eriksen and Kelly, 2007). For example, gross domestic product (GDP) measures current production levels without capturing the processes that brought about the existing circumstances. Therefore, GDP only measures current social vulnerability (Birkmann, 2007). Secondly, indicators capture current conditions rather than providing understanding about how future vulnerability can develop (Eriksen and Kelly, 2007). This criticism is somewhat alleviated by the use of scenarios for future conditions. However, Preston et al. (2011) noted that scenarios were more commonly used for biophysical factors (in 2/3 of the assessments studied) than for social and economic factors (in 1/3 of the assessments studied).

Other researchers as shown herein argue that indicators are not appropriate for vulnerability assessments because vulnerability is complex and intangible. First, indicators simplify conditions and are incompatible with complex topics such as climate vulnerability (Niemeijer, 2002; Barnett et al., 2008; Hinkel, 2011). Vulnerability is complex for the human systems (whether they are individuals, communities, or nations), and for physical environmental conditions/processes (such as precipitation patterns and habitats). Therefore, indicators compromise details and accuracy of representations about these systems and processes (Barnett et al., 2008; Hinkel, 2011). These systems are complex and lack clear boundaries; therefore, are inherently difficult to capture through a simplified metric such as an indicator. Secondly, vulnerability is intangible because the capacity to be harmed can only be measured partially when an event occurs. The potential to be harmed is still not quantified.

2.2.6. Conclusion to vulnerability and risk review

It is clear that vulnerability assessments require explicit definitions, careful consideration of the indicators used, the purpose, the scale of the assessments, and limitations. Most importantly, transparency is needed regarding whose vulnerability is being assessed. Given these considerations, vulnerability assessments can provide information which is useful in lieu of actors operating in an information vacuum. This is especially relevant to this study because limited information has been identified as one of the challenges local authorities face when trying to adapt to climate change (Roberts, 2008; Baker et al., 2012; Bierbaum et al., 2013).

The lack of Irish climate change vulnerability studies means that information is not available to aid local governments in preparing for climate change. Currently available vulnerability assessments do not provide usable information within Ireland and there is a need for locally based climate change vulnerability assessments. Within the vulnerability framework, it is clear that two types of information are needed:

a) climate-related exposure and impact information, and

b) adaptive capacity and adaptation information.

Even more clearly, usable information is needed for Irish local authorities' climate change preparations. A study prepared at the national scale would provide limited information about areas within the country that were more vulnerable. Conversely, a study that frames the climate change exposures, impacts and vulnerability at local authority scale will provide information to the front line responders and highlight the challenges that each local authority will be facing. This section has described adaptation theory and approaches to vulnerability assessments. Because this research focuses on local government adaptation, the research is also framed by the following examination of governments and factors are affecting their actions.

2.3. Governance and responses to climate change by government

This section moves from a focus on vulnerability and adaptive capacity generally, to a focus on climate change governance. Governance theory is presented as possible avenue to explore governmental capacities and an action, beginning with a brief overview of governance theory, followed by an examination of the interactions between the different levels of actors, and concludes with examples of responses to climate change by governments.

Within the governance discourse, some theorists argue that governments no longer have absolute power to steer society (e.g. Rhodes, 1996). Conversely, other theorists maintain the dominance of governments even as new actors enter the picture (e.g. Bell and Hindmoor, 2009). Common to both perspectives, governments have undergone changes in their functions. Traditionally, government served society by regulating the economy, providing public service and defence (Storey, 2001). Whereas, under the new paradigm of governance, private entities are helping to determine society's path, and governments are changing the type and quantity of activities they do with a greater reliance on diplomacy (Peters and Pierre, 1998; Stoker, 1998; Rhodes, 2007). Therefore, governing actors now include government as well as private citizens, private enterprises and non-state agencies (Kjær, 2004; Bailey and Maresh, 2009). According to multi-level governance theory, some actors operate within a tiered, non-overlapping hierarchy with a fixed number of actors (e.g. the EU, national governments and local governments). Meanwhile, other actors are more transitory, sector specific entities that are established as needed (e.g. River Basin Management Districts) (Hooghe and Marks, 2003; Bache and Flinders, 2004).

Each of these entities takes action through hierarchical structures, markets, or networks. When the actor is government, most actions are taken through the hierarchical structures of government agencies; when the actors are private companies or semi-state bodies, most actions are taken through markets or networks. Granted, these categories are generalisations, and each actor has scope to interact with the other types of actions. A brief discussion about markets and networks is followed by a more comprehensive consideration of hierarchical structures as relevant to the current questions regarding governmental capacity to address climate change. Market actors, including transnational corporations and supranational organisations, affect government's capacity to steer society through deregulation and extensive foreign direct investment (Storey, 2001; Marsh et al., 2006). This is mitigated in that states control market entry into the domestic arena and regulate the terms of their operation. The market forces are problematic for environmental issues because externalities are not accounted for in the prevailing economic structures (Hills, 2005; Jordan et al., 2010).

Networks affect government's capacity to steer as well through pressure to amend public policy. Non-governmental organisations, such as Friends of the Earth, raise the profile of environmental issues. Private enterprise networks, such as the Irish Farmers Association, seek advance their members' business interests. In addition, local governments have formed international networks separate from state regulation as in the case of the International Council for Local Environmental Initiatives. The extent to which these networks are effective is limited because "the actions of networks will in most circumstances be carried out within a context of state power, power that can be withdrawn if deemed necessary" (Peters and Pierre, 2006:217). Further, although networks are accountable to their members, they have no legal mandate or requirement to publicly report their progress or to achieve certain goals (Peters and Pierre, 2006).

With regard to hierarchical structures, state sovereignty is being challenged because the traditional way governments have been governing is changing in two ways: they have transferred service provisions to the private sector and they have ceded partial autonomy or sovereignty to the supranational level[4]. This is important because the core functions of government are changing, and "voters continue to demand that [the] state act to mitigate the effects of natural disasters, bank failures, environmental catastrophes, social disorder and threats to public health" (Bell and Hindmoor, 2009: 31). However, what is government and how does it achieve collective goals? Government actors use hierarchical structures ('bureaucracy') to govern where central government designs

[4] The European Union is especially strong on this point. Member states explicitly transfer partial autonomy or sovereignty to the European Union through the Treaty on European Union and Treaty on the Functioning of the European Union (CEC 2010).

policies, and sub-national government agencies implement the policies (Reed and Bruyneel, 2010). These actors jointly are termed 'governments', and are the formal entities that provide public services and facilitate collective action (Stoker, 1998; Kjær, 2004). These formal entities identify common goals through electoral mandates, design and implement policies to achieve these goals, and regulate behaviours (Pierre and Peters, 2000).

Within these hierarchical structures, national governments have a defining role for local authorities' policies (Cash and Moser, 2000; Betsill and Bulkeley, 2004; Adger et al., 2005; Næss et al., 2005). This role can be beneficial or detrimental. On the positive side, central government initiatives jumpstart locally based policies (Aall et al., 2007; Urwin and Jordan, 2008). On the negative side, lack of statutory requirements and guidance constrain local actions (Demeritt and Langdon, 2004; Feiock, 2009; Hanak et al., 2008; Russel and Turnpenny, 2009; Falaleeva et al., 2011; Bierbaum et al., 2013). For example, in 1995 Norwegian local authorities deferred responsibility to national government for flood repairs: local responses were limited to large scale technological fixes that were funded by central government (Næss et al., 2005). Similarly, UK planners view climate change as a higher-level issue (Wilson, 2006). In the United States, climate plans were much stronger where there were state mandates (Tang et al., 2010).

This issue is closely tied to resource constraints because local authorities have a broad range of prescribed actions and limited resources. Two key supports for local actions are financial backing and statutory regulations. Without financial support, local authorities are less able to move forward (Betsill and Bulkeley, 2004; Sygna et al., 2004; Urwin 2005; Moser and Ekstrom, 2010; Bierbaum et al., 2013). For example, local authorities in Mexico have failed to make effective policies due, in part, to assigned responsibilities for climate change without the necessary resources (Lankao, 2007). Puppim de Oliveira (2009) found similar circumstances in both developed and developing countries: the Mie Prefecture in Japan, Saxony-Anhalt in Germany, and Sao Paulo, Brazil. Similarly, but limited to mitigation, Irish Energy agencies lacked resources to take climate measures (Davies, 2005). In each of these cases, inadequate financing resulted in climate measures falling short.

The other key support, statutory regulations, can help local governments to withstand pressure from individuals and to prioritise long-term agendas. Without performance criteria related to climate change (Preston et al., 2009; Burch, 2010), local authorities are subjected to pressures of competing priorities (Betsill and Bulkeley, 2004; Sygna et al., 2004; O'Brien et al., 2006; Granberg and Elander, 2007; Khan, 2007; Biesbroek et al., 2010; Burch, 2010; Moser and Ekstrom, 2010). This international information is illustrated by a recent court case in Limerick, Ireland. In 2009 county councillors and two individuals challenged a county manager's refusal on a zoning matter. In this case, the Limerick County Manager refused planning permission for rezoning agricultural land for residential development. This refusal was overturned by the county councillors, and maintained by the county manager. Further along, the high court supported the county manager in prohibiting ribbon development (P.J. Farrell & Anor v Limerick County Council [2009] IEHC 274; EnviroSolutions, 2009). This example shows that private interests challenge local governments.

This brief overview of governance theory provides a glimpse into the complexities facing governments as they attempt to steer society generally and to address climate change challenges. This theoretical framework is a useful lens to examine the government's structures and actions, evaluate the successes and shortfalls, explore the driving forces, and recommend solutions to improve matters in Ireland and further afield.

Equally important as the governance actors and structures, the interactions between the different levels of actors greatly affect potential actions. While each of the foregoing factors (central government initiatives, resources, and statutory regulations) affect local government actions, further support from formal administrative structures is needed (Lawrence et al., 2015). In an examination of New Zealand multi-level climate change governance, Lawrence et al. (2015) documented the need for an integrated approach (including local, regional and national scales) with administrative structures to integrate practice. This echoes the findings of other researchers (e.g. Wilbanks, 2007; Adger et al., 2005; Jordan et al., 2005) who recognise that external pressures (from above and horizontally) affect the capacity of governments to address climate change.

In addition to higher-level influences, the effectiveness of local measures is affected by inherent strengths and weaknesses in local governments. Local governments have an inherent strength in that they are small-scale and this gives them flexibility to innovate through small-scale projects. Proactive local governments can be test grounds for advancing new agendas and practices (Puppim de Oliveira, 2009). While some cases require financial investment from national government, sometimes soft measures are possible and require limited funding. An inherent strength is that local governments can build citizen support for higher-level agendas through information knowledge transfer. For example, local actors can champion causes. This was shown in Boston for climate adaptation and in New York City for emergency preparation (ICLEI, n.d.).

The weaknesses in local government structures and responsibilities constrain their actions because of shortfalls in expertise, information, and lack of service provision. They lack technical expertise related to climate change (Urwin, 2005; Hanak et al., 2008; Tribbia and Moser, 2008; Moser and Ekstrom, 2010). They have insufficient information to devise plans for climate change (Allman et al., 2004, Sygna et al., 2004; Hanak et al., 2008; Bierbaum et al., 2013). Lastly, local governments have limited capacity to influence actions by private individuals (Holgate, 2007; Hanak et al., 2008; Biesbroek et al., 2010). This is an issue because adaptation "requires the involvement of a variety of public and private actors in the problem-solving debate" (Biesbroek et al., 2010:446). According to the IPCC, these governance shortfalls have not been fully explored and remain a key knowledge gap (Kovats et al., 2014).

Despite these reported governance shortfalls, in some cases governments are still playing a leading role. For example in the UK, most adaptation has been carried out through government initiatives (Tompkins et al., 2010). These actions included research, planning, networks, legislation, awareness raising, implemented change, training, and advocacy. All these actions do not mean that there have not been remaining shortfalls. In the UK there were more actions for water supply and flood risk management than there were for other sectors: transport, agriculture/forestry, and biodiversity/ conservation (Tompkins et al., 2010).

Information is lacking regarding the foregoing governance shortfalls as well as regarding governments as a main actor at the international, national, and subnational levels. At EU level, the Commission of the European Communities (CEC) issued the 2007 Green Paper on Adaptation (CEC, 2007), the 2009 White Paper: Adapting to climate change (CEC, 2009), and the 2013 Adaptation Strategy (CEC, 2013a) and the EU Adaptation Strategy Package for numerous sectors e.g. coastal and marine issues (CEC, 2013b). These actions prompted member states' actions (Keskitalo, 2010c).

As detailed in the following sections, most national governments are in the early stages of adaptation at a strategic level, and some national governments have advanced to concrete adaptation plans. At subnational level, states and regional groupings have started taking action as well. At local level, adaptation successes are mixed, and researchers disagree whether local authorities have made significant progress on climate adaptation (e.g. Bulkeley and Betsill, 2003; Allman et al., 2004). All levels face challenges in moving forward on climate change and the governance discourse offers some insights about why. This section evaluates current government adaptation, with a focus on national and subnational governments, and examines shortfalls in climate adaptation actions and the potential for governance theory to help advance climate measures.

2.3.1. National level policies and actions

Both in developing and developed countries, some governments have frameworks without concrete actions; while others are more advanced with both frameworks and actions (Swart et al., 2009; Westerhoff et al., 2010; Mullan et al., 2013; EEA, 2013). A shortfall of EU Directives and national frameworks is that they generally do not include details on subnational requirements and allocation of tasks (Boyle, 2000; Jordan et al., 2005; Swart et al., 2009; Biesbroek et al., 2010; Mullan et al., 2013). This has relevance to the current study given that Ireland's national policies do not include subnational details (Chapter 1). Most countries' frameworks are early stage adaptations of increasing knowledge, building capacity, and adopting high-level strategies (Keskitalo, 2010b; Koch et al., 2007; Tompkins et al., 2010). Fewer countries have advanced to concrete adaptation plans (Swart et al., 2009). The adaptation shortfalls are examples of governance shortfalls because national governments are not advancing a coordinated approach that incorporates other actors (Rhodes, 1996, 2007; Peters and Pierre, 1998; Stoker, 1998) and other governmental levels (Keskitalo, 2010a).

National governments are building capacity by increasing knowledge and adopting strategies. They are increasing knowledge by assessing climate impacts, vulnerabilities and possible adaptation measures. They are building capacity by disseminating the "relevant information to help inform decision-making at various levels" (Westerhoff et al., 2010:331). Developed countries within the EU, the OECD, and elsewhere have national adaptation strategies (Swart et al., 2009, Westerhoff et al., 2010; Mullan et al., 2013). Within the 32 EU member states, 16 have published adaptation strategies (EEA, 2013). Within the 34 OECD countries, 18 have a published high-level strategy (Mullan et al., 2013). Similarly, Canada and Australia published adaptation frameworks in 2005 and 2007 respectively (Westerhoff et al., 2010). Even when they have a national framework, climate change adaptation may not be mainstreamed into national regulations or objectives, as in the case of Sweden (Keskitalo, 2010b). This has been identified as a problem because national responses need to be coordinated among different government departments as well as with private sector actors (Koch et al., 2007).

These national policies are in the early stages and they fall short of significant progress on adaptation (Tompkins et al., 2010). They lack details about implementation, regulations, finances, government operations, and sub-national requirements (Mullan et al., 2013). The most relevant shortfalls (for local adaptation) are the lack of implementation details and allocation of subnational responsibilities. Implementation details are missing about concrete adaptation measures which are being monitored or evaluated (Swart et al., 2009; Biesbroek et al., 2010; Westerhoff et al., 2010; Mullan et al., 2013). There are some exceptions. In the OECD, 10 of the 18 countries have published adaptation plans with concrete measures (Mullan et al., 2013). In addition, some countries (e.g. Finland, Germany and the UK) have comprehensive policies that include monitoring, review and enforcement (Swart et al., 2009).

The other key shortfall of adaptation strategies is a general lack of detailed provisions for allocation of subnational responsibilities (Biesbroek et al., 2010). Governments acknowledge that climate change adaptation involves actions at all levels (from international down to local and individual levels), but few include detailed requirements for local authorities. This is important because national governments are "overseeing the development and implementation of adaptation measures, and allocate the responsibility for the coordination of their implementation across the lower scales" (Swart et al., 2009:109). One exception is the UK with requirements and economic incentives for municipalities (Keskitalo, 2010a). The foregoing examples suggest that many national governments are not making sufficient progress on climate change.

In addition to horizontal challenges, governments are subjected to vertical challenges with pressure from above and below. These interactions between higher and lower levels of government have prompted an expansion of governance theory with a proposal of multi-level governance (Hooghe and Marks, 2003). Because multi-level governance recognises these interactions and varied types of administrative structures (Bache and Flinders, 2004), it has potential to help advance climate measures. From above, supranational organisations such as the EU are eroding state sovereignty (Kettl, 2000; Keskitalo, 2010a). Because policies are determined collectively, individual Member States cannot always control agendas at EU Council or Parliament level. Thereafter, Member States are obliged to transpose EU policies into national law regardless of their position during negotiations. If Member States fail to formally adopt and implement policies, the European Court of Justice may impose economic sanctions.

As stated earlier with regard to climate change, the EU's pressures have prompted member states to take action (Keskitalo, 2010c). For example, 80 per cent of new environmental legislation enacted by EU Member States was driven by EU directives (Jordan et al., 2012). Therefore, in some ways this erosion of state sovereignty may help safeguard people and the environment even though issues such as climate change are a low priority among the public as discussed in Chapter 1. Even so, the EU's policies have shortcomings and leave a policy gap.

The EU's practice of setting overall policy agendas without details about subnational implementation leaves a policy gap in two ways (Boyle, 2000). First, responsibilities can be devolved to local governments without resources to implement the policies. For example, national governments were encouraged to establish regional tiers of government when the EU offered funding for regional governments. In the Irish case, regional authorities were established, but central government limited their effectiveness through constrained funding, lack of authority, and limited designated staffing (Boyle, 2000). Second, effective implementation may or may not be achieved in daily operations at subnational levels (Peters and Pierre, 1998; Rhodes, 2007; Urwin and Jordan, 2008; Bell and Hindmoor, 2009). Despite EU mandates, Irish River Basin Management Plans were delayed (CEC, 2012) and Waste Management Plans fall short on required incinerators (McCoole et al., 2011). Therefore, some of the shortfalls in climate adaptation may be explained by administrative factors as detailed in governance theory. Further, the administrative factors and "governance mechanisms might lead to greater adaptive capacity, and that tradeoffs may exist between some of the variables (e.g. equality of decision making and knowledge availability)" (Engle and Lemos, 2010:12). At the same time, the foregoing section has focused on the national actions, without details about how well local authorities are moving forward. This is very relevant for the current study because the foregoing national shortfalls suggest there may be scope for subnational actors to play a role in climate adaptation.

2.3.2. Subnational level policies and actions

Separate from national actions, actions are needed by subnational and local governments. Even if national actions were well advanced and widespread, subnational actions would still be required. Effective policy actions require coordinated efforts including regional and local actions (Kelly and Moles, 2000; Galarraga et al., 2011). Local and regional governments can fill the gap left by national shortfalls and help to advance climate measures (Bulkeley and Betsill, 2003; Schreurs, 2008).

Local government's role is also supported by the subsidiarity principle, which calls for actions to be taken at the lowest level (Collier and Löfstedt, 1997). This section details some subnational actions being taken by regional governments and local authorities, and includes an expanded discussion about the subsidiarity principle. Through this review, potential actions are identified that may provide a framework to assess local government actions in Ireland.

2.3.2.1. State and regional governments

Regional governments present a mixed level of successful actions. In some cases such as Germany, subnational regions are taking a leading role (Galarraga et al, 2011; Frommer, 2013). Regional adaptation strategies have been adopted by several German regions using national government funds. These newly adopted approaches included "regional networks of actors from science, business, administration and public agencies" (Frommer, 2013:103). While some countries such as Germany have strong regional autonomy, other countries such as Ireland and the United Kingdom have more limited regional autonomy (Bullmann, 1997). Also notable, the structures where environmental policies are placed vary when comparing countries. This has direct relation to the mixed scales of established structures: some countries such as Germany with its strong regional autonomy as compared to Ireland with its more varied regional structures as discussed in Chapter 1. These varied structures and cross-cutting scales are likely to remain a feature of environmental policies and in the presence of "existing scalar modes of political life which have their roots in varied economic, social and cultural realities" (Meadowcroft, 2002:177).

In some countries, regional governments coordinate local government efforts, provide an expertise base for local authorities, and balance central government's strategic focus with local government's parochial focus (Huang, 1997; Granberg and

Elander, 2007). In other countries, regional authorities have a much more limited role due to resource issues and diluted accountability. As noted in Chapter 1, Ireland's regional authorities have limited potential due to limited resources (Boyle, 2000). Similarly, as shown in Figure 2.11, Norwegian regional actions have been less successful than individual municipalities' actions because "municipal planning processes involving more than one municipality often tend to result in planning documents with few concrete goals that are often 'forgotten'" (Aall et al., 2007:89).

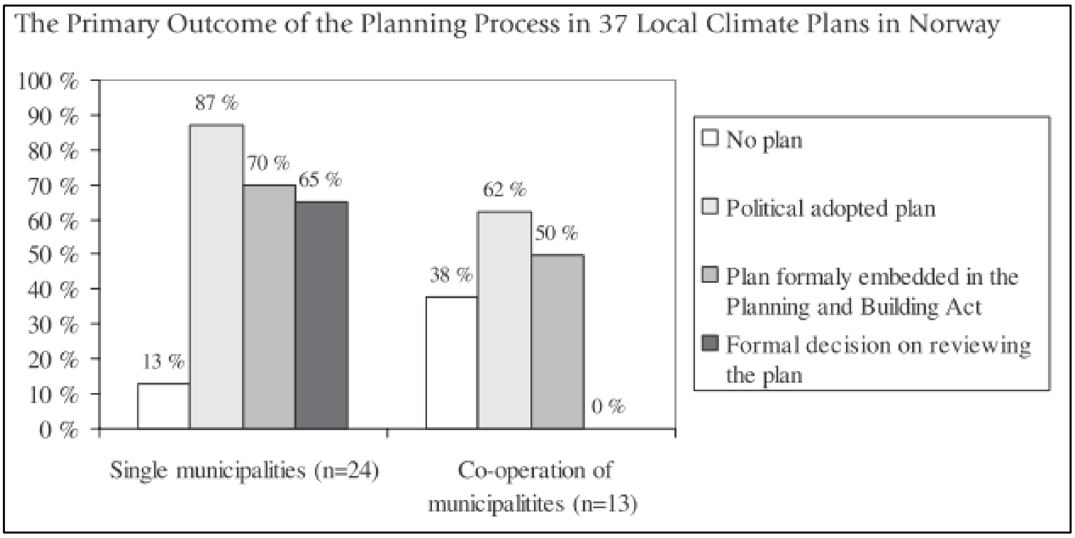


Figure 2.11 Norwegian local climate plans' outcomes (Aall et al., 2007)

In other larger nations such as the United States, state governments are serving this function both with state actions and through regional groupings (Knigge and Bausch, 2006). US states have adopted adaptation plans, prepared greenhouse gas inventories, participated in registry programmes, adopted carbon caps, and established offset requirements for power plants (Byrne et al., 2007). As of 2014, 68% of states have adopted climate action plans as shown in Figure 2.12 (C2ES Center for Climate and Energy Solutions (C2ES), 2014). Further, as shown in Figure 2.13, regional initiatives, e.g. the West Coast Governor's Global Warming Initiative, have been adopted by many state governments (Knigge and Bausch, 2006).

These regional groupings have taken action; however, it is less clear whether they represent a new governance sphere or transitions within the existing governmental agencies. The members are established entities coming together to set new targets and goals, and their membership is voluntary. In an examination of Canadian and England regional adaptation partnerships, Bauer and Steurer (2014) reported that the regional groupings have limitations due to their voluntary status and due to the links between existing government entities. Also notably, the perceived ownership by member of the regional groupings was greater where they were established from bottom-up initiatives rather than state-led initiatives. Therefore, the potential for increased regional cooperation in Ireland rests more with the individual actors than with the national government structures.

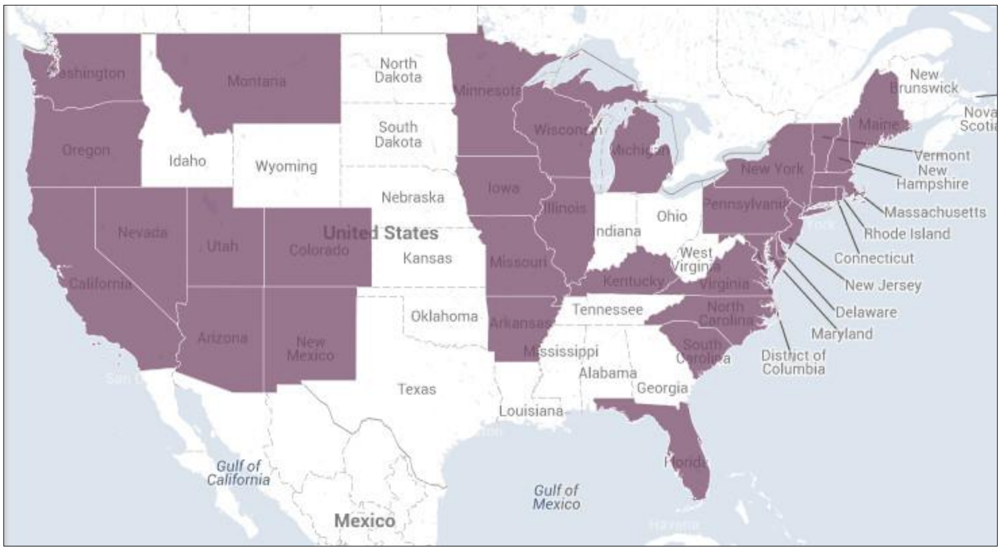


Figure 2.12 Subnational climate action plans in United States (C2ES, 2014)

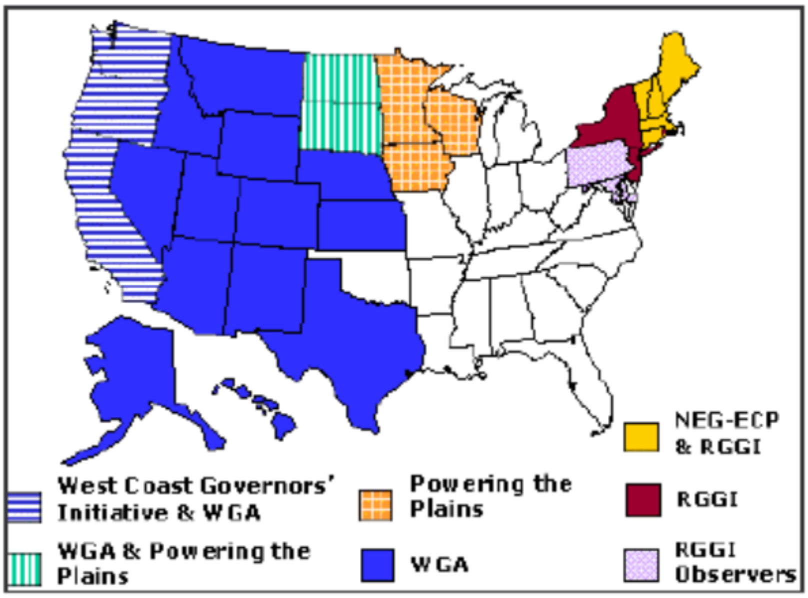


Figure 2.13 States participating in regional climate actions (Knigge and Bausch, 2006)

Given the foregoing, it is clear that there is no one-size-fits-all structure or scale for environmental policy (Adler, 2005), and examining climate change responses requires consideration of the different actors, scales, and interactions between the different levels of governance (Adger et al., 2005). This is especially true with an emerging policy area such as climate change where the established structures will need to adapt to the new challenges or new structures will be needed to effectively address climate change. New Zealand local government studies confirm that flexible responses are required with a strong focus on shared learning through informal and formal networks (Lawrence et al., 2015).

2.3.2.2. Local governments

The information about local government actions and potential is mixed. Some local government are acting independently from national actions, while others have yet to take actions to address climate change. Further, the types of actions have differing levels of effectiveness. For example, the information about government plans to address climate change are clear; however, the information about how effectively those plans are implemented is less clear (Storbjörk and Uggla, 2014). This section makes the argument that local authorities do have a role to play based on 1) examples of actions taken and 2) theoretical grounding shown by the subsidiarity principle. Conversely, the potential for proactive local authorities is tempered by the constraints presented by multilevel governance issues. This section concludes by considering Ireland's position on the continuum of climate change preparations.

Some proactive local governments are adapting independently from the national actions. This is occurring in countries with national adaptation strategies, such as the UK and Sweden, as well as in countries without national adaptation strategies, such as Australia and the US (Granberg and Elander, 2007; Keskitalo, 2010a; Davies, 2009). Beyond these proactive local authorities, most local actions involve mitigation and early stage adaptation (Bulkeley and Betsill, 2003; Allman et al., 2004; Wilson, 2006; Tribbia and Moser, 2008). Overall, most local authorities are making limited progress on adaptation (Allman et al., 2004; Næss et al., 2005; Aall et al., 2007; Granberg and Elander, 2007; and Tang et al., 2010). Exceptions to this are listed below along with a consideration of adaptation barriers. In addition to the international examples herein, some information was published in 2008 about the Irish local authority actions by the Office for Local Authority Management (OLAM). Further information about local authority actions, internationally and in Ireland, is needed to better understand the Irish circumstances.

Local actions include building capacity and adapting infrastructure. Local governments build capacity by raising awareness, making public commitments, and establishing climate action teams and plans (Wheeler, 2009; Coffee et al., 2010; International Council for Local Environment Initiatives (ICLEI), n.d.). By raising awareness local governments are taking initial steps toward improved governance through interactions with the public. Irish examples also include raising awareness; however, were more internally focused such as internal energy audits, working groups, and staff procedures (OLAM, 2008). However, the lack of standardised approach for climate change at city and county level (OLAM, 2008) suggests weak governance structures, especially when considering links between the different government levels.

Local authorities also build capacity by making public declarations and joining international networks: e.g. the UK Nottingham Declaration, Climate Local, the Covenant of Mayors, and ICLEI. Participation in international networks is a key governance mechanism and highlights the potential for individual actors to jump scales and access support for local initiatives (Bulkeley and Betsill, 2003). Two voluntary initiatives in the UK were the Nottingham Declaration and Climate Local. Between 2000 and 2008, over 330 UK councils signed the Nottingham Declaration (Nottingham Declaration Partnership, 2008). The more recent Climate Local initiative was launched in 2012 as a platform for local authorities to promote climate change activities. 89 local authorities (25%) have signed up to the initiative, and a further 380 members (65% of councils) are part of the Climate Local Network (Local Government Association, 2014). The European Covenant of Mayors includes 3,000 local authority members who have voluntarily joined and submitted a Sustainable Energy Action Plan to the European Commission (Covenant of Mayors, 2013b). Lastly, ICLEI is a worldwide organisation with voluntary membership. As of March 2014, 422 cities and local governments are members of ICLEI's carbon*n* Cities Climate Registry with 830 commitments (de Moncuit, 2014). Membership in these networks is voluntary, and participation varies even within the same country. For example in Sweden, some municipalities, such as Växjö, participate international and regional networks, while other municipalities, such as Sundsvall, focus on local and regional network cooperation

(Gustavsson et al., 2009). In other cases, such as Ireland, the network participation is rare (Davies, 2005).

Climate action teams have been established, for example, in California (Wheeler, 2009) and Chicago (Coffee et al., 2010). Climate action plans are in place e.g. Toronto's 2007 *Climate Change, Clean Air and Sustainable Energy Action Plan* and 2008 *Ahead of the Storm: Preparing Toronto for Climate Change.* In addition by 2005, 50% of UK local authorities had "acknowledge[d] climate change as a factor [in their development plans] which needs to be considered in all their policies and proposals" (Wilson, 2006:616).

Local governments adapt infrastructure which is prompted by a mix of reasons: some anticipatory, some reactive. Anticipatory measures include increasing green spaces in cities (Howard, 2009), accommodating sea level rise for bridges e.g. the Confederation Bridge in Canada and metro stations e.g. in Copenhagen, Denmark (Gagnon-Lebrun and Agrawal, 2006), and managing flood risk to climate-proof current infrastructure e.g. the Thames Barrier (Greater London Authority, 2011). In each of these cases, the governments were addressing current threats and preparing for the future. In Canada, transportation issues between Prince Edward Island and New Brunswick had been ongoing and required a significant financial investment which prompted the Canadian government to look forward into the 100-year lifespan including "a maximum 2.25 m rise in water level above the Canada Geodetic Datum . . . [and] that sea level at the site would rise by 0.3 m over 100 years" (Bell et al., 2003:38). In Copenhagen, the "Metroselskabet[5] [Metro Company] has been working with climate change adaptation since planning and dimensioning the first metro in 1993-1995" (Danish Ministry of the Environment/Danish Nature Agency, 2014:2). In London, flood risk management began as a response to a serious flood in 1953, and has evolved to include protection against future high tides (Roggema, 2009). In these cases, disentangling the drivers is challenging because it is uncertain whether the actions would have been taken without the existing threat.

In some cases, such as Växjö in Sweden, local governments set goals and pressure their national government to raise the standards throughout the country (Granberg and Elander, 2007). In addition, local authorities are leading by example as

[5] "Metroselskabet is owned jointly by the City of Copenhagen (50 per cent), the Danish State (41.7 per cent) and the City of Frederiksberg (8.3 per cent)" (Metroselskabet, 2013:42)

they reduce their emissions and build their adaptive capacity. For example, Växjö was a climate leader with its 1996 "goal to become a fossil-fuel-free city", which resulted in international awards (Gustavsson et al., 2009:65). Several small-scale sustainable energy projects include retrofitting existing properties and building new low-energy housing units. In addition, many local authorities are reducing energy demand and/or using renewable energy sources in their administrative buildings. These actions are also occurring in Ireland as showcased in the *Local Authority Climate Change and Energy Efficiency Measures: Best Practice and Current Initiatives*. Councils also use renewable sources including solar panels (Kildare, County Limerick, Mayo, South Dublin, and Wexford), wind turbines (County Waterford and Wexford), wood fired boilers (Kerry, Mayo, and Wexford), and geothermal heat pumps (County Cork and Kerry) (OLAM, 2008: 19–20).

These examples show that local authorities have the potential to advance local climate measures. These local authorities have overcome challenges by accessing support, working through partnerships, and recognising the secondary benefits of tackling climate change such as potential employment and improved quality of life (Allman et al., 2004). At the same time, these measures often represent early stage actions and full adaptation will require more extensive actions. For example, even in cases such as the UK where local adaptation is prioritised, 94% of UK local authorities have not progressed beyond public commitments and risk assessment (Davies, 2009). The UK progress may be further limited since local authorities are no longer required to report their progress (Department for Environment, Food and Rural Affairs, 2010). Similarly, in the United States, most local governments only assess options and plan for future actions (Perkins et al., 2007). This is unlikely to change before tangible impacts occur (Shackley and Deanwood, 2002; Wilbanks, 2007; Amundsen et al., 2010).

While most local authorities are in the early stages, there is still a case to place adaptation decisions at the local level based on the subsidiarity principle. Subsidiarity aims to place actions at the lowest, most effective, level of a multi-tier system (Føllesdal, 1998). The underlying premise is that governance decisions should be taken as close as possible to the citizen (Jordan, 2000). This has been applied specifically to climate change studies in British Columbia, Canada, where:

> Political leaders in both Delta and the District of North Vancouver seemed to feel that the local level is the most effective scale at which to pursue effective action on climate change, because local politicians 'live, breathe, and know [the community] way better than anyone else' (in the words of one senior Delta politician).
>
> (Burch, 2010:7579)

When actions are taken at the lowest effective level, there will be increased autonomy, accountability, and goodness-of fit policies (Adler, 2005). Local autonomy is limited by top down policies. When central government designs policies, and local governments implement them, there is limited space for local governments to tailor policies to the local circumstances. Accountability is increased when citizens can monitor local actions (Jordan, 2000). Policies are better tailored to local variations when they are designed at the local level, which increases their effectiveness:

> Ecological systems vary tremendously from one place to the next. The failure to take into account local environmental conditions – let alone local tastes, preferences, and economic conditions – leads to 'one-size-fits-all' policies that fit few areas well, if at all.
>
> (Adler, 2005: 136)

The foregoing information advises about local government potential and actions in other countries; however, information is lacking regarding Ireland's local progress on adaptation. The only information about local climate change has been the localised studies noted in Chapter 1, and the energy related matters reported by OLAM. Similarly, as discussed in Chapter 1, weak local governance has been reported in the areas of sustainable development, social inclusion and local networks. Further, the Limerick example of contested zoning practices suggests a need to expand the information about Ireland's local capacities and actions.

2.3.3. Conclusion to governance review

Based on the review of governance theory and government adaptations, it is clear that these matters are highly complex. Overall, though, governments are generally still in the early stages of addressing climate change, both at national and local levels. More specifically, the existing research suggests that local authorities may, or may not, have capacity to contribute to climate change adaptation. It has been shown that addressing local authority adaptation from a climate change perspective alone does not address all the factors that are affecting local authority adaptation. Governance theory offers an additional framework that addresses the external pressures on government in achieving goals, as has been shown in the case of climate change herein. Therefore, this research addresses a pressing need to advance the knowledge about how to move towards an adapted Ireland, with a focus on the local authorities' role. Irish local authorities have been tasked with preparing adaptation plans without the necessary knowledge to proceed. Only by establishing a baseline of exposures and actions, and identifying factors that affect local authority adaptation, will the information be available for local authorities to be proactive on climate change rather than being unprepared for this challenge.

2.4. Discussion and research objectives

While many researchers have assessed climate impacts at different scales for several countries, and some Irish researchers have assessed impacts at the national scale in Ireland, there are no assessments framed at the local level where most adaptation occurs. This thesis is the first significant piece of research on this topic in Ireland. As stated earlier, without this information local authorities lack the information necessary to prepare for climate change. This research will assess the ways that climate change will affect Irish local authorities (Aim 1) through the following objectives:

Objective 1: identify the local authorities that face greater challenges associated with climate change than other local authorities in Ireland. This will require consideration of the different sectors and climate change overall.

Objective 2: identify good practice examples and adaptation deficits by Irish local authorities. This information will showcase how to advance local authority policies and practices as well as provide a baseline for the current level of actions.

In addition to the foregoing knowledge gap, there is a lack of information about the factors that affect progress on local authority actions in Ireland, for climate change and governance issues. Therefore, this research will assess the factors that affect adaptation by local authorities (Aim 2) through Objective 3: identify how adaptation deficits can be fixed through a greater understanding of related governance issues.

These Aims and Objectives are illustrated in Figure 2.14 which shows the conceptual framework for this research.

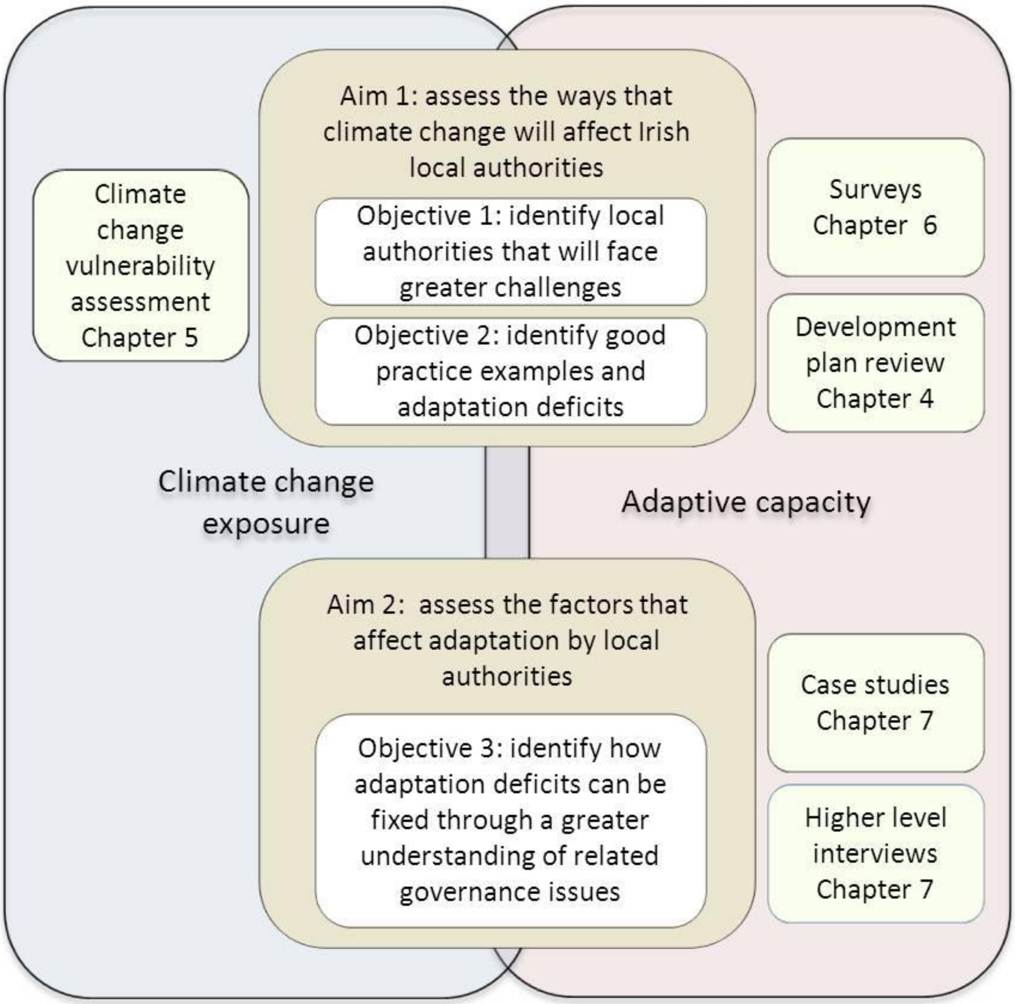


Figure 2.14 Conceptual framework for this research

This framework incorporates the underlying themes, the Research Aims and Objectives, and the methods. The underlying and overlapping themes of climate change exposure and adaptive capacity (shown in grey and pink) draw on the conceptual models of the EEA (2008) and the IPCC (2014). Situated within, and relevant to both underlying themes, the Research Objectives (shown in white) are nested within each of the Research Aims (shown in light brown).

The methods (shown in yellow) are placed within the framework with specific intent. First, each method is placed within an underlying theme which reflects the primary focus of that methodology. The climate change vulnerability assessment focuses on the climate change exposure primarily, and the remaining methods focus more on the adaptive capacity of the local authorities. Second, each method is placed adjacent to the relevant Aim: those relevant to Aim 1 are in the top half of the figure, and those relevant to Aim 2 are in the bottom half of the figure.

This chapter has thus identified the state of knowledge regarding climate change vulnerability, government actions to address climate change, and offered governance theory as a framework to explore this subject. Building on this groundwork, Chapters 3 documents the data sources and methodology used for this study.

Chapter 3. Methodology

As noted in Chapters 1 and 2, information in Ireland was lacking about climate-related exposures, adaptation, and factors that affect adaptation by local authorities. To build the knowledge, this research used a two-strand methodology with a five methods. The first strand assessed vulnerability through a four-step scoping of sectoral exposures, adaptive capacity, sensitivity/impacts, and combined vulnerability. This research strand relates primarily to Aim 1 to assess the ways that climate change will affect Irish local authorities. The methods associated with Aim 1 were the climate change vulnerability assessment, surveys and development plan review.

The second research strand explored ways to enhance local authorities' adaptive capacity through case studies and interviews with government officers. This research strand relates primarily to Aim 2 to assess the factors that affect local authority adaptation. The methods associated with Aim 2 were further analysis of the survey responses from the first research strand as well case studies and higher level interviews. This chapter describes and evaluates the data and methodology used for each research strand and the overall research approach.

3.1. First research strand – climate change vulnerability assessment

As discussed in Chapter 2, assessing climate change vulnerability requires consideration of exposure, sensitivity, impacts and adaptive capacity (Füssel and Klein, 2006; EEA, 2008). This research applied this framework and refined the focus to local authorities as the front line responders for hazardous events, and as responsible actors for planning in their jurisdiction. This required a vulnerability assessment framed at the local authority level. Therefore, the data sources were selected to assess Irish local authorities' climate change vulnerability and adaptive capacity. Table 3.1 below provides an overview of the assessment's components, which is sorted by sectors to maintain continuity with the Methodology Chapters and Results throughout the thesis.

The first research strand evaluated the climate-related vulnerability of Irish local authorities. This vulnerability assessment contributes to knowledge by combining publicly available data from the different sectors and evaluating the combined impacts. The sectoral exposures and vulnerabilities "are more useful than a single index" (Adger et al., 2004:2). This research also contributes to knowledge because the information has not been analysed in Ireland at the local authority level. The methodology design incorporated the cautionary notes from the critiques of vulnerability and risk assessment as reviewed in Chapter 2. These included the need for explicit definitions, conformance to recognised approaches, suitability for the study area, variations within the study area, and limitations of indicators for complex processes.

The climate change exposures in Ireland included water resources, agriculture, forestry, biodiversity, and marine and coastal environments (Sweeney et al., 2003; Dunne et al., 2008; Sweeney et al., 2008). Given that this research is assessing the adaptive capacity of local authorities, this research limited the focus to water resources, biodiversity, and coastal environments (sea level rise and coastal erosion). Flooding and landslides were also included because local authorities are first responders for the events. The six sectoral exposures are grouped with the relevant indicators shown as the same colour in Figure 3.1. The combined physical climate exposure is shown in white as is the overall climate change vulnerability.

In Ireland, no comprehensive dataset existed that covered the breadth and depth of climate change considerations, especially at the local level. The existing datasets offered parts of the information, with four main limitations: climate change considerations, scale, narrow focus, and availability. First, with regard to climate change considerations, most relevant datasets have not addressed climate change for impacts as identified in Chapter 1.

Second, with regards to scale, the data has been compiled at either the national scale with limited details for local authorities, or, at the local scale covering only a limited area. In cases where national scale data is available, local authorities are left to discern how their jurisdictions will be affected. In cases where locally scaled data is available, information is provided for the specific jurisdiction and leaves other local authorities with an information gap. Third, the datasets have a narrow focus in the context of climate change because they address single sectoral concerns such as flooding with limited consideration of other environmental or policy matters.

Fourth, availability of some datasets is limited which inhibits local authorities' use of the information. For example, the national coastal erosion study by EOLAS in 1996 has not been digitized. In addition, those datasets that were available digitally were not standardised to one format. Rather, they were in different formats according to the needs of the producer and holder of each datasets. Bringing together the different datasets, and scaling them to the local authority scale, required extensive processing which was carried out in a geographical information system (GIS) framework.

Taking into account the foregoing caveats, existing data was used to provide a starting point to assess how climate change will affect Irish local authorities. The climate change impacts in Ireland included water resources, agriculture, forestry, biodiversity, and marine and coastal environments (Sweeney et al., 2003; Dunne et al., 2008; Sweeney et al., 2008). Given that this research is assessing the adaptive capacity of local authorities, this research limited the focus to water resources, biodiversity, and coastal environments (sea level rise and coastal erosion). Flooding and landslides were also included because local authorities are first responders for the events. This data was collected from a variety of sources which included publicly available records, unpublished data held by lead agencies such as the Office of Public Works (OPW), and local authorities as shown in Table 3.1. Selection of these data sources required careful consideration in terms of the data's completeness, original purpose, reliability, and format as discussed below in relation to each dataset. In cases where data was inadequate in any of the four qualities, it was supplemented with data collected during the course of this research. Exposure was based on climate change projections, recorded events, and land attributes. Adaptive capacity information was based on the policies and resources of local authorities.

Table 3.1 Climate change vulnerability assessment components.

(a) Sectors	(b) Indicators	(c) Data source
Flooding	Recorded flood events	National Flood Archive (OPW)
	Winter rainfall % increase	Met Éireann, unpublished data
Landslides	Peat bog areas	CORINE land cover database 2006
	> 15° slope areas	Digital Elevation Model (EPA)
	Recorded landslides	GSI National Landslide Database
Water supply	Public water supply at risk	Remedial Action List 2013 Q3 (EPA)
	Summer rainfall % decrease	Met Éireann, unpublished data
Biodiversity	Protected sites	NHAs, SACs, SPAs (NPWS)
	Protected species	Protected species (NPWS)
Coastal erosion	Coast at risk	EOLAS study (NCEC, 1996)
	Erosion trends	EUROSION (Lenôtre, 2004)
Sea level rise	Elevation <1 metre	Digital Elevation Model (EPA)
	Storm surge	Ireland in a Warmer World (C4I)
	Coastal aquifers	Groundwater Aquifers (GSI)
Adaptive Capacity	Development plans	Database created in this research
	Climate change strategies	Database created in this research
	Forward planning staff	DECLG 2012 planning statistics

For the body of the chapter, the above datasets are described and evaluated by data type: climate change projections, recorded events, land attributes, policies, and resources. Each of these datasets was selected with careful consideration of how they would add to the assessment of the specific sector, as well as the overall physical climate-related exposure. In cases where other relevant datasets were available, the merits and limitations of those datasets are discussed. In addition, preference was given to datasets held by nationally recognised bodies where the validity of the dataset was more likely to be recognised by the local authorities. Local authorities are the primary subnational administrative unit with responsibility for their area, and they operate under the umbrella of national government. These local authorities are comprised of 34 city and county councils (as listed in Table B.7 in Appendix B). In 2014 the Local

Government Reform Act amalgamated 6 of the city and county councils into 3 county councils (Limerick County Council (previously Limerick County and City); Tipperary County Council (previously North Tipperary and South Tipperary); and Waterford County Council (previously Waterford County and City). This data collected through this research was based on the full 34 city and county councils and the results as such are reported herein.

Maps and tables of each dataset were prepared during the course of the research and are included in Appendices A and B respectively. This chapter concludes with a discussion about the overall quality of the available data.

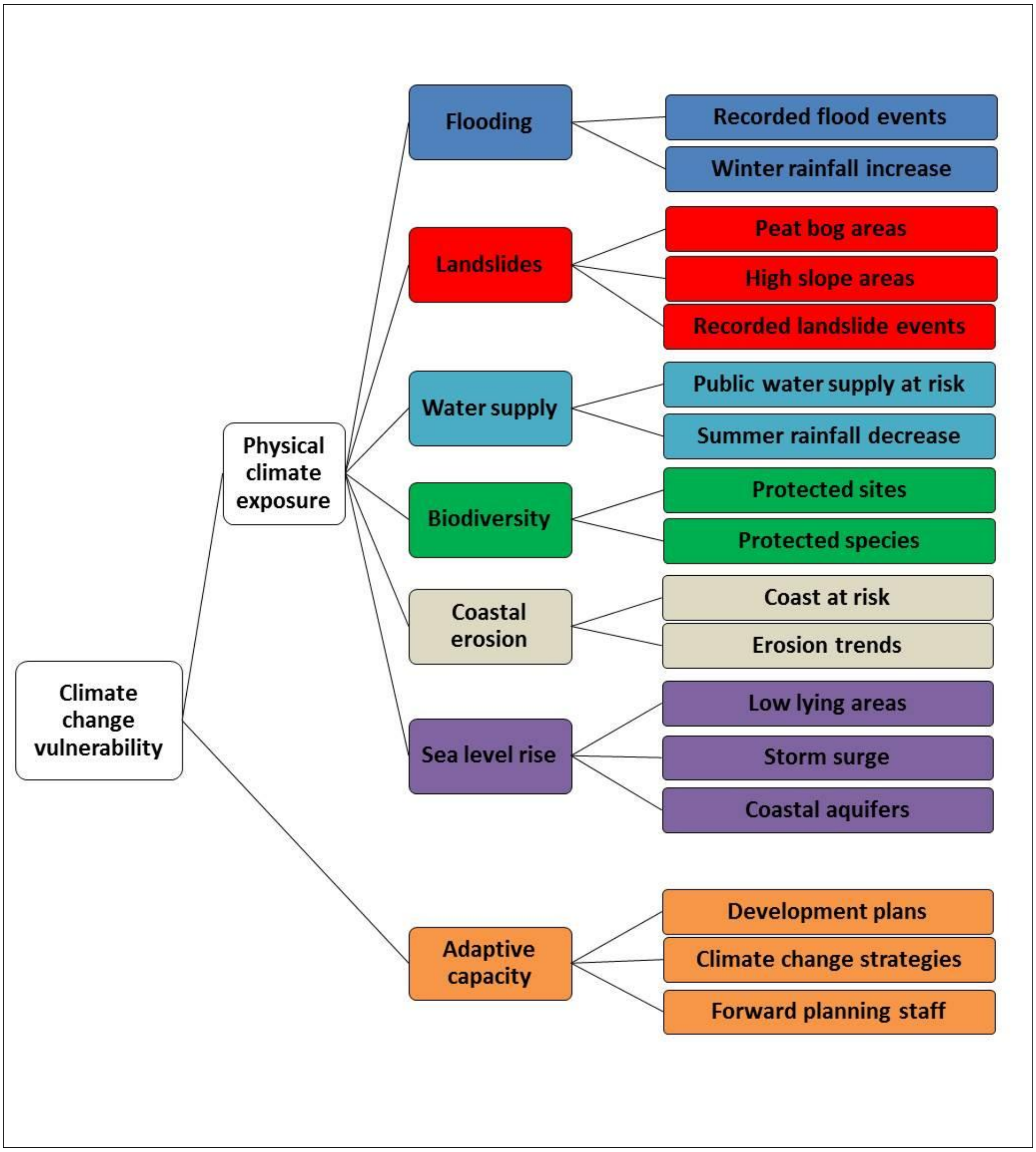


Figure 3.1 Framework for climate change vulnerability assessment

These assessments used a GIS approach, based on the EEA (2008) framework, to bring together the diverse datasets, evaluate the spatial distribution exposures, and generate output for communication with the local and national government staff members. The core element of this assessment was to bring together information on two levels: from a sectoral to a more holistic approach, and consideration of local experiences within the national context. The holistic approach is a shift from sectoral risk assessments such as flooding towards an approach that considers the challenges for all relevant sectors presented by climate change. The national context is a shift from examining the challenges in a specific county towards considering these challenges within a relative ranking framework. Specific challenges in a county are addressed by the local authority and will benefit from additional consideration if their risk is greater than the national average. At the same time, even in cases where relative values are low, there still remains the absolute exposures, impacts and vulnerability as will be experienced through events such as increased flooding. Therefore, this framing does not reduce the need to address the individual challenges and provides local authorities with the opportunity to address interactions between sectors.

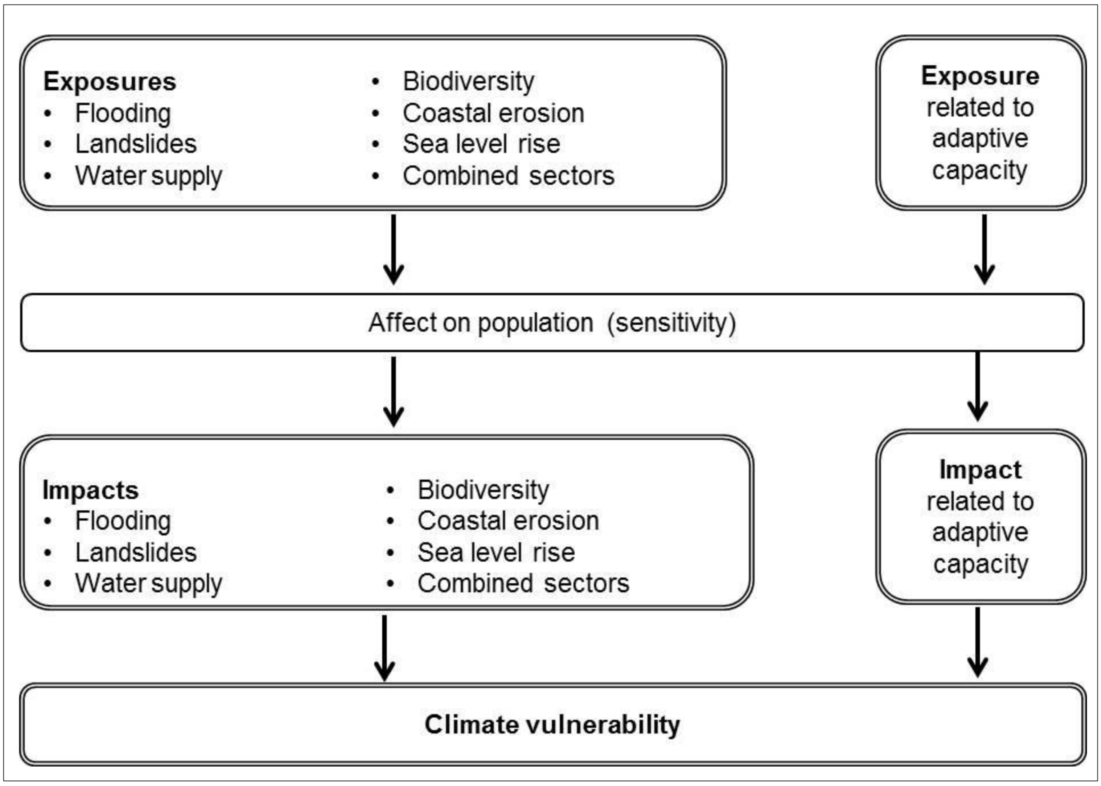


Figure 3.2 Schematic for assessment steps

Breaking down the assessment into sequential steps, as illustrated in Figure 3.2, shows the building blocks of the climate change vulnerability assessment. This provides a transparent accounting of how the data was analysed and allows for use in future studies. The sequential steps, as further detailed below, were as follows:

1) sector exposures were evaluated,
2) adaptive capacity was evaluated,
3) sensitivity and impacts (consequences of exposures) were evaluated, and
4) climate vulnerability was evaluated.

3.1.1. Evaluating sectors and combined physical exposure

The exposure to climate change was examined for each sector individually and combined with the others. The same methodology was used for each sector to provide results which could be combined for overall physical exposure. These six sectors, as shown in Figures 3.1 and 3.2, were flooding, landslides, water supply, biodiversity, coastal erosion and sea level rise. This section describes the steps taken for all the sectors and then details the specific indicators used for each sector.

The indicators and sectors were evaluated for the counties using the following steps:

1) For each indicator in a given sector
   a) Data from national datasets was collected and labelled per county.
   b) The value for each county was calculated:
      i) in cases where events were counted, the sum of the events was used as the county total, e.g., for flooding - recorded flood events; or
      ii) in cases where a condition was evaluated as a percentage of the total land area, the average percentage of values for the county was used as the county total, e.g. for flooding – winter rainfall % increase.
   c) The county values were analysed for the distribution over the whole country.
   d) Five categories were created using the Jenks natural breaks method in ArcGIS. The Jenks method was selected because the class breaks are set to "best group similar values and maximize the differences between classes" (ESRI, 2012). Other methods were considered including quartile, standard deviation or equal interval methods. As Smith (1986) noted when comparing traditional data classing methods for choropleth maps, "one must exercise great care when setting class intervals and select a method which will maximize accurate cartographic communication (Smith, 1986:62). In comparing the alternative data classing methods, Smith (1986) found that the quartile, equal interval, and

standard deviation methods were compromised when the data was skewed. Based on the comparison of the different methods, the Jenks optimization method "provided the best results in all cases" (Smith, 1986:67). The resulting categories were ranked from one (very low exposure) to five (very high exposure). It is acknowledged that using classification systems has limitations when attempting to quantify the effects of a given phenomenon, and these results are presented with this cautionary note.

2) For the sector:
    a) The indicator scores were averaged for each county value,
    b) The county values were analysed for distribution over the whole country, and
    c) Five categories were created using the Jenks natural breaks method in ArcGIS. These categories were ranked from one (very low) to five (very high).

As part of the process of developing this methodology, the possibility of weighting the different indicators was explored. Different metrics, such as data reliability and expert knowledge, were considered. This approach was not selected for two reasons. First, the reliability of the datasets varied, as discussed by sector below. Second, if the individual indicators were weighted, objective criteria would be needed to increase the robustness of this assessment. The potential benefits of this approach are acknowledged, and future research could evaluate and incorporate a weighted approach.

All counties were assessed for flooding, landslides, water supply and biodiversity. The two remaining sectors (coastal erosion and sea level rise) relate to coasts, and only counties located on the coast were assessed for these two sectors. Further discussion of the coastal/non-coastal classification is included in the sections for coastal erosion, sea level rise, and overall physical exposure.

The sectors and related physical exposures were assessed at the county scale for three reasons. First, administrative responsibilities are set at the county level, with the exception of the local authorities that are situated within the broader county boundaries (cities of Cork, Galway, Limerick, and Waterford; and within the Greater Dublin Area: Dublin City, Dún Laoghaire-Rathdown, Fingal and South Dublin). Ireland's government is highly centralised: there is no comprehensive regional structure, and few responsibilities have been devolved to town councils. In addition, national government restructured the subnational authorities with the town council responsibilities being assumed by the county councils. In addition, the Local Government Reform Act (2014) abolished the town councils completely. Second, data is available at county scale for flood events and biodiversity. Third, the relative ranking methodology presents challenges when combining cities and counties because of data resolution and ranges. Within smaller jurisdictions e.g. cities, some data, such as precipitation, show limited variation.

The ranges of data required special attention. In cases where data was available at the city level, such as sea level rise, considerations related to the relative ranking methodology came into play. This assessment was designed to evaluate relative vulnerability for all cities and counties in the Republic of Ireland. This brought with it design considerations because the administrative boundaries are not standardised: some counties especially in the west of the country cover large geographical areas, while other counties in the east have a more limited geographical extent. Similarly, the relatively small data values of the cities, as compared to the large values for large counties, meant that each category would encompass a great range of values. This would result in most cities being ranked as very low exposure simply because they cover a smaller geographical area and have fewer events occurring.

3.1.1.1. Flooding

Flooding exposure was evaluated using two indicators: reported flood events and winter rainfall increase. Detailed flood risk assessments are needed to plan for flooding in all areas of Ireland. These assessments are being carried out by the Office of Public Works (OPW) in cooperation with local authorities. They are in process and, unfortunately, have not been completed for the whole country as of this writing. Once completed, the detailed flood risk assessments can guide local authorities more fully in planning decisions for flood risk management. Robust flood predictions for planning purposes is "hampered due to the relatively weak signal to noise ratio of climate change compared with the large inter-annual variability of rainfall and river flows" (Murphy et al., 2011:82). In addition, flood risk is affected by flood defences and the specifics of each catchment (Murphy and Charlton, 2008). Therefore, the results regarding relative flood exposure must be considered with these caveats. Some indication of future flood risk can be obtained using the two indicators as described below.

The recorded flood events indicator is comprised of the 5156 recorded events in the National Flood Archive maintained by the Office of Public Works (OPW) (accessed most recently 11 May 2014) (OPW, 2011). This database includes historical information collected from local authorities, state bodies and members of the public. Therefore, it is closely aligned with local authority experiences and examining each county's recorded flood events places their local concerns within the national context as well as allowing for an assessment of relative flood exposure for each county.

While the database is the best available source, there are three limitations. First, the records are "not a comprehensive catalogue of all past (fluvial/tidal) flood events in the country" because reporting is discretionary (OPW, 2011). Further, known flood events are only added to the national flood archive once documentation has been provided to the OPW. In some cases, there has been a delay in local authorities submitting this documentation (Butler, 2014). Second, information for some floods is more detailed than others as to extent, water level, and magnitude. Third, the flood records include a mix of non-recurring and recurring floods as shown on Map A.4 in Appendix A. Of the 5165 recorded floods, 1728 records were non-recurring floods (one event per record), and 3437 records were recurring floods (multiple events per record). Therefore, implications for future flood risks may differ for those events which were non-recurring as compared to recurring floods. Additionally, information is not included regarding flood alleviation measures which may affect future risk.

The winter rainfall increase indicator brings projected changes into focus and suggests areas that will face more challenges in relation to flooding. Climate model outputs at a resolution of 10km^2 were used, which compared the baseline time period (1961-1990) and mid-century (2031-2060). While, climate modelling has recognised limitations due to uncertainty of the complex processes in the environment and future development pathways, the model outputs represent the best available information about future changes. The modelled changes are more certain for greenhouse gas concentrations and less certain for precipitation and other changes. Further, precipitation projections are used with consideration that results are "indicative of likely changes" (Fealy and Sweeney, 2008:32), but that "the accuracy of the detail is questionable" (Dunne et al., 2008:11). Therefore, these projections should be used as indicative trends rather than for detailed planning (Sweeney, 2008).

Two datasets were available for climate change projections from the Community Climate Change Consortium for Ireland Project (C4I) (Dunne et al., 2008) and Irish Climate Analysis and Research Units (ICARUS) (Fealy and Sweeney, 2008).

Detailed descriptions of the modelling parameters and processes are included in these publications. The following sections evaluate the datasets and their limitations with a specific focus on precipitation changes and storm surge.

Precipitation change data was based on climate modelled from the C4I project instead of the alternative dataset from ICARUS for the following reasons. Both datasets offered information about the projected changes, and had different strengths and limitations. The strengths of both datasets were favourable resolution, available timelines, and robust modelling practices. Favourable resolution was available from both datasets at $10km^2$ resolution (coarser global climate model outputs were downscaled through regional climate models). Available timelines were similar for the projections over the next century for temperature, precipitation and other climatic variables. This research used mid-century projections (2031-2060) as compared to baseline observations (1961-2000) (Dunne et al., 2008).

Robust modelling practices were employed by research groups as described in their publications (Dunne et al., 2008; Fealy and Sweeney, 2008). Specifically relevant to this research, both datasets used ensemble modelling, which is the combination of multiple global climate models to avoid "suppression of crucial uncertainties" and "to try and account for different model and emissions uncertainties" (Fealy and Sweeney, 2008:25). Both datasets used the IPCC's scenarios for global development trends (Nakićenović et al, 2000). These scenarios are based on the driving socioeconomic forces and related emissions with four main storylines: A1, A2, B1, and B2. The A1 scenario is associated with the greatest increases in greenhouse gas concentrations; and the B2 with the least increases over the next century (Nakićenović et al, 2000).

Each dataset's limitations relate to the available scenarios of the modelled outputs. While both C4I and ICARUS used ensemble modelling with multiple global climate models and scenarios, the available outputs were limited. The ICARUS dataset outputs were for the combined A2 and B2 emission scenarios. The C4I dataset available outputs were for the A1B scenario (a subset of the A1 storyline). The C4I dataset was selected in lieu of the ICARUS dataset because the A1B scenario used in the C4I data was more consistent with current emission trends (Fealy, 2009; Tech, 2012).

The dataset was refined by season, analysed for changes between baseline and mid-century, and identified by county. Precipitation changes between the baseline observations and mid-century projections were analysed in ArcGIS by calculating the percentage increase comparing the projected and observed values. Seasonal precipitation changes were used to provide greater resolution on specific impacts. Winter months (December, January, and February) have been associated with high flood risk; however, flood events have occurred outside the winter months (e.g. November 2009). The increased flood risk outside the winter months is not represented in this assessment.

The records were identified by county using the select-by-location tool. The precipitation dataset was queried for features that intersected with each county file from the CSO boundary dataset, and the appropriate county name was entered for each record. For example, the precipitation dataset was queried for features that intersected with the County Longford file, and Longford was entered into the county field for each selected record. Some coastal cells did not overlap with any county because they were adjacent to land but did not overlap with the CSO shapefiles. In these cases, individual cells from the precipitation dataset were selected using the select-features tool, and these cells were assigned to the closest county. In some cases, precipitation points adjacent to islands did not overlap with the CSO county file. First, the precipitation points adjacent to the Aran Islands and in Galway Bay were classified as Galway. Second, the precipitation points adjacent to Inishturk Island were classified as Mayo.

These indicators provide some information about the distribution of flooding throughout Ireland, framed at the county scale. The limitations of the data require that these results be considered as indicative rather than for planning purposes.

3.1.1.2. Landslides

Landslide exposure was evaluated using recorded landslide events, high slope areas, and peatlands. Landslide exposure has been evidenced by historical records which can be linked to land attributes and to climatic conditions. The historical records provide some insight into landslide exposure in Ireland and a comprehensive accounting will require further work as described below. The land attributes relating to landslide susceptibility are slope, soil types, and topographic flow directions (Bone, 2012). This research included high slope areas (defined as greater than 15º) and peatlands as indicators for high exposure. While the importance of topographic flow directions is acknowledged, this was not included within this research due to data constraints. It is recommended that future research regarding landslide exposure, especially when for specific areas at risk, adopt this more complex methodology.

The recorded landslide events are all records in the National Landslides Database maintained by the Geological Survey of Ireland (GSI). This dataset includes 912 landslide records, which occurred between 1900 and 2013 as shown on Map A.5 in Appendix A. The GSI dataset was compiled from journals, media sources, the 2006 study in Mayo's Breifne area, and the 2012 research by Mouchel consultants as part of work to derive metrics for landslide identification. Records of existing landslides in East Leinster and Cork have been expanded as part of the work in 2012 (see Figure 3.3). As stated in the Mouchel report, these areas were selected in part as major development zones with a focus on infrastructure and private developments (Bone, 2011:17). The GSI has incorporated these records into the National Landslides Database. This inclusion has resulted in very high numbers of events in East Leinster and further research is likely to add events from other areas of the country.

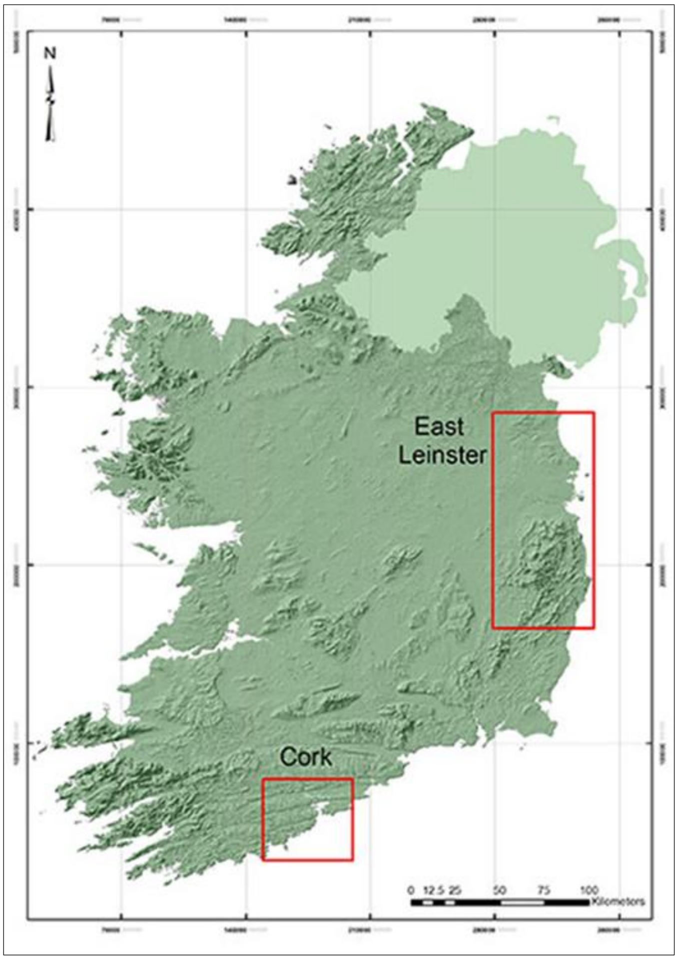


Figure 3.3 Landslide study areas (Bone, 2012)

Within the landslides database, these 912 events include 314 peat-related events. While most recorded mass movements in Ireland involve peat, landslides are also a concern for urban areas as evidenced by the 41 events which occurred within cities and towns such as Dún Laoghaire and Bray. Similar to the flood event database, the landslides database is not a comprehensive accounting of all landslides which have occurred in Ireland. For example, with reference to County Mayo some landslides were included while others have not yet been added (Creighton, 2006). Specifically, the national database includes only 22 landslides even though 52 landslides were reported in a case study of the of the Bréifne area in Sligo, Cavan and Leitrim (Pellicer, 2006), and a further 264 events have been documented in the Bréifne study area (Creighton, 2009).

The other limitation of the landslides database relates to the data sources. Most (721) of the landslide records did not include details about the data source. Only 29 were based on a site visit, and only 3 were based on a technical report. Many records were collected from journals (44) or provided by email (34) to the GSI. Therefore, this landslides assessment has limitations and further research is in process. In August 2013, the GSI commissioned further studies to evaluate landslide susceptibility in counties Kerry and Mayo (GSI, n.d.). These results were not available at the time of this writing.

The two other indicators to assess landslide exposure were areas of high slope and peatlands. The high slope areas were derived from the EPA's Digital Elevation Model and all cells in the raster that were greater than 15º slope were defined as 'high slope areas' based on the recommendations from the GSI work (Creighton, 2006) and Mouchel work (Bone, 2012). The digital elevation model (DEM) dataset covers each hydrometric area in Ireland and is held by the Environmental Protection Agency. The original dataset was based on "aerial photographs with a scale band between 1:30,000 and 1:75,000" coupled with "Contours and Spot Heights taken from the 1:50k OS Discovery vector datasets" (Preston & Mills, 2002). This dataset was useful for determining high slope areas as well as low lying areas. While the DEM includes all of Ireland, it provides a broad-brush approach because the error range is between ± 4 and ± 7 metres (Coveney and Fotheringham, 2011). Thereafter, the areal extent of high slope areas was calculated as a percentage of each county's total land area.

The spatial extent of peat land areas was calculated as a percentage of the total land area for each county. In counties with high amounts of peat land cover (such as Donegal, Kerry and Mayo), the exposure for landslides is greater. Similar to the high slope indicator, the areal extent of peat land areas was calculated as a percentage of each county's total land area.

Climatic conditions play a role in landslide initiation, and precipitation projections under climate change were explored as an additional indicator in evaluating landslide exposures. This indicator was not used for two reasons: first, the effect of increased precipitation on landslides has been contested. While Dykes et al. (2008) predict no increase in landslide events with climate change; Dixon and Brook (2007) predict that changes in precipitation patterns will increase landslide risks. The Geological Survey of Ireland's Landslide Working Group supports this prediction, based on their predictions of drier summers and wetter winters. Bringing together the three factors of recorded events, slope and peatlands gives some indication of the relative landslide exposure of counties in Ireland.

3.1.1.3. Water Supply

Water supply exposure was evaluated with two indicators: public water supply at risk and summer precipitation changes. Water supply provisions require detailed assessments similar to flood risk assessments and similar caveats about precipitation projections apply to this sector.

Because of the recent shifts in public policy, water supply provision is a short-term consideration for local authorities. At the beginning of this research, water supply was under the local authority remit. Recently national government has reallocated responsibility to the newly established Irish Water and instituted domestic water charges. These changes in public policy will affect the prognosis for water supply and especially how it will affect Irish local authorities. Water supply was retained as a relevant sector because the transition to Irish Water will not be complete until 2019.

Water supplies are likely to be affected by climate change through "decreases in precipitation and increases in evapotranspiration [that] cause low soil moisture content, which in turn causes low groundwater recharge" (Murphy and Charlton, 2008:47). Local authorities face challenges because 82% of the Irish public receives its water from the 930 public water supplies (Hayes et al., 2013). Two datasets were considered for water supply. Information about water supply was initially considered from the National Water Study and the Greater Dublin Sustainable Drainage Study. These studies were not used because the two studies were incompatible for measurement techniques, areas covered, and timelines.

Since this data is to evaluate where Ireland's water supply will be at risk with changing climate, an alternative source was selected: the EPA's "Remedial Action List for Public Drinking Water Supplies" (RAL) as of 2013 Q3 (EPA, 2013). The RAL identifies all public water supplies that have failed to meet minimum standards (Hayes et al., 2013). This dataset is updated annually and a comparison of the initial list and current figures show that local authorities have made progress in improving water quality. The initial list in 2008 identified 339 supplies at risk, and as of September 2013, only 147 supplies remain on the list (Hayes et al., 2013).

The percentage of each county's public water supplies at risk was used, based on the number of supplies at risk as a percentage of total public water supplies for each county. In cases where some water supplies were serviced by City Councils, the totals for the City and relevant County were combined and used as the total for the County in the assessment (See Table B.3 in Appendix B). This indicator does not capture the climate change effects on private water supplies which serve approximately 11% of the population as they are beyond the remit of local authorities.

The summer precipitation indicator gives some insight into how climate change may prompt shifts in the seasonal distribution of precipitation, with associated drier summers. The data limitations for projected precipitation changes as discussed regarding flooding also apply here. Decreased precipitation for the summer months (June, July, and August) was used to provide greater resolution on the impacts on water supply. Other major factors associated with water supply problems relate to condition of infrastructure, land use and population growth (Hall, 2013). Future research could incorporate an expanded assessment of the different water stress factors.

3.1.1.4. Biodiversity

Effects on biodiversity were evaluated with two indicators: protected sites and protected species. The combination of these two indicators highlights the counties with most exposure due to limited protected areas and few protected species. In these cases, added concern and further studies are warranted. Climate change productions were considered for sector, but were not used because species react differently to changing climate depending on their particular requirements (Coll et al., 2012).

The protected site indicator is a measurement of the designated land area as a percentage of the total land area for each county. The national dataset was used which is held by the National Parks and Wildlife Services (NPWS) for all protected sites in the Republic of Ireland at a scale of 1:10560, as summarised in Table 3.2 below and shown on Map A.11 in Appendix A. This dataset was created as a nationwide mapping of the protected sites (NPWS, n.d.). This dataset has limitations related to current status: the boundaries have not been updated since the maps were created, and any degradation of specific sites is not recorded.

Table 3.2 Protected area classifications and relevant legislation

Protected sites and statutory backing	
Designation	Statutory Requirements
Special Areas of Conservation (SAC)	EU Habitats Directive (92/43/EEC)
Special Protection Areas (SPA)	EU Birds Directive (79/409/EEC)
Natural Heritage Area (NHA)	Wildlife Amendment Act (2000)
Proposed NHA (pNHA)	non-statutory basis since 1995

Because many of these designated sites cover the same area, the GIS shape files for each designation were merged, and the area covered by the amalgamated protected sites area was used for each county. Additionally, because counties vary widely in size, the percentage of each county's land area that is designated as protected was used.

The protected sites indicator, which reflects how much space is protected within each county, is a starting point to show counties that have limited protected sites within the national context.

The second indicator, protected species, represents all "Red Listed" species identified in each county as per the NPWS dataset. The NPWS dataset includes all "Red Listed" species (protected by the Habitats Directive and EU Birds Directive), which includes those that are endangered, vulnerable or threatened (NPWS, 2011; International Union for Conservation of Nature, 2012). The dataset is made up of "key datasets and records held by the NPWS. They do not comprise the complete archive of biodiversity held by the NPWS" (NPWS, 2012).

While the NPWS dataset provided valuable information, there are four limitations: presence data, coarse resolution, omission of highly sensitive species, and omission of factors outside the protected areas. First, the NPWS dataset is made up of presence data, which is a recorded sighting of the relevant species. Therefore, species may no longer be present at that location. In addition, species may exist but be unrecorded in other places. Second, the coarse resolution of species data ($100km^2$, with some records at $10km^2$, and all records accurate to $1km^2$) provides limited insight about the specific location of flora and fauna. Third, highly sensitive species data is not publicly available for sixteen endangered species (a detailed list of these species is available on the NPWS website). Fourth, the protected areas have been designated by national government as areas with recognised protected species; however, these species also exist outside the designated areas, and this factor is not captured within this dataset.

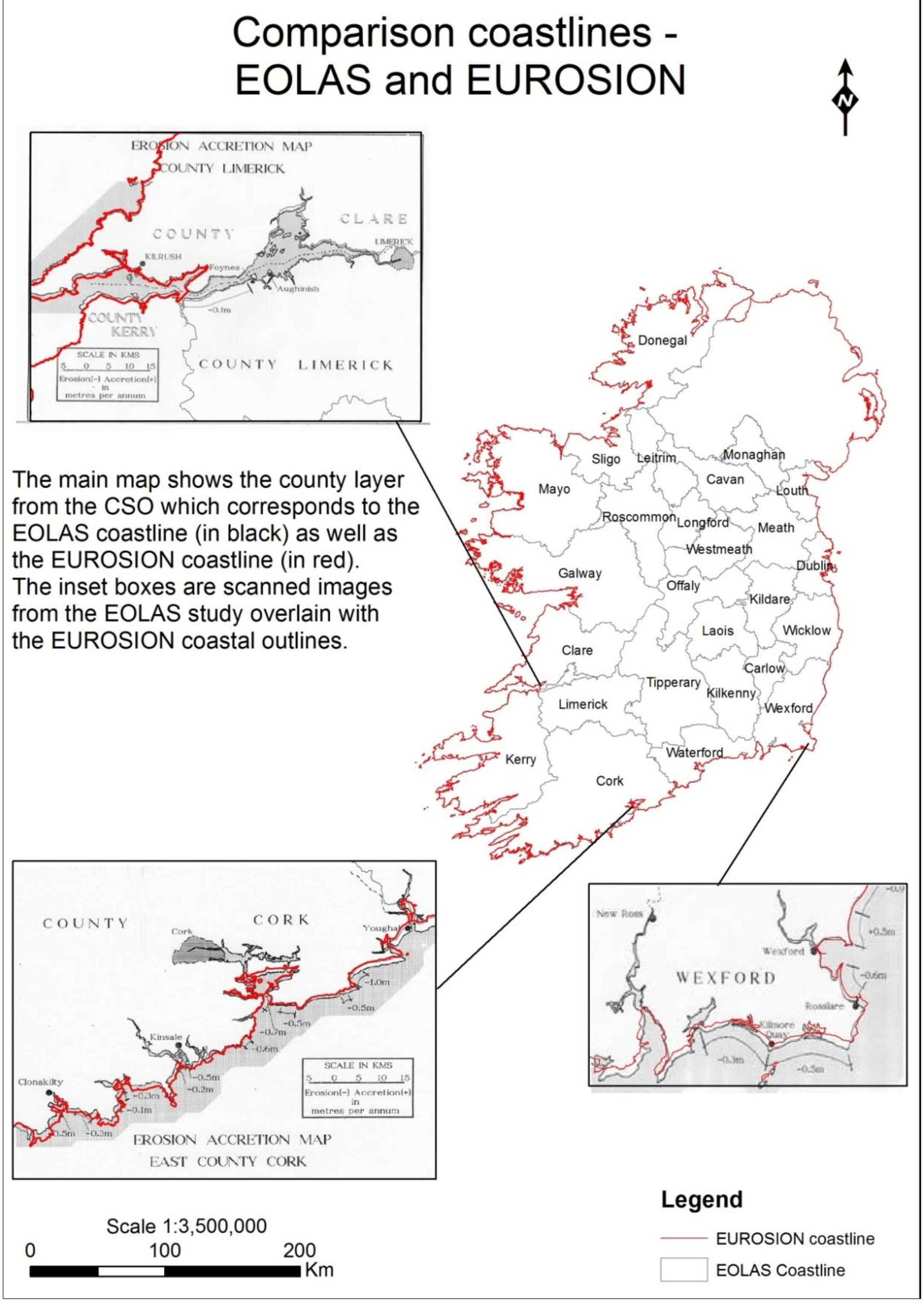
3.1.1.5. Coastal Erosion

Coastal erosion exposure was evaluated using two indicators: coastline at risk and coastal erosion trends. Coastal erosion is expected to increase with climate change because of changing weather patterns and sea level rise. Coastal erosion is a complex process with changes at a very small scale even within a single beach. These factors and limitations specific to each dataset as discussed below. The first indicator, coastline at risk from the EOLAS dataset, used the local expert knowledge of local authority engineers to identify areas of coastal erosion based on the landforms within each county. The second indicator, coastal erosion trends from the EUROSION study, used observed changes within a national context.

The coastline at risk indicator is based on the dataset from the 1992 EOLAS study commissioned by the National Coastal Erosion Committee. "The committee [National Coastal Erosion Committee] initiated a 'needs study', carried out by each county council to identify the basic land forms present around the coast and to quantify the extent of erosion problems" (National Coastal Erosion Committee, 1992:6). This was the first coordinated national study that moved beyond the existing local coastline studies in Ireland. This dataset had three limitations: 1) data collection practices and criteria were not standardised, 2) detailed information was only available for selected coastal segments, and 3) the dataset is more than 20 years old. More recent studies are in process by the Office of Public Works; however, the datasets were not available while the assessment was being prepared.

Coastal erosion trends indicator is based on the dataset from the pan-European EUROSION study, which analysed coastal erosion changes between 1990 and 2004, based on information provided by participant member states (Lenôtre et al., 2004). This study covered Ireland's coast and advanced the knowledge about coastal erosion. Each coastline segment was classified as aggrading, eroding, stable, or no information. There are three limitations: the extent of coastal erosion is not assessed, no consideration is taken as to the types of land use, and information was not available for parts of the coast. First, the eroding segments can be those with aggressive erosion or areas with more limited erosion. Second, erosion in some places will have less effect on people and sensitive habitats than others; this is not evaluated within the EUROSION study. Third, information was unavailable for parts of the coast. Information was more available in the east than the west; therefore, the erosion problems may be under-represented in the west (shown on Map A.14 in Appendix A).

The EOLAS dataset (coastline at risk indicator) differed from the EUROSION dataset (coastal erosion trends indicator) because some researchers addressed estuaries differently than others (as shown in Map 3.1). The different approach to estuaries meant that many counties had different coastline lengths especially in the Shannon Estuary. In the EOLAS study, the local experts from some councils included estuaries in their coastline (Clare and Limerick included the Shannon). Conversely, local experts from other councils excluded estuaries from their coastline (the Cork and Waterford harbours and the Boyne estuary were excluded). The EUROSION study also excluded some estuaries such as the Shannon. This meant that, within the EUROSION study, partial data was available for Clare and no data was available for Limerick. To resolve this discrepancy with regard to the current assessment, Clare was classed as coastal and Limerick as non-coastal. Limerick's exposure to coastal erosion is acknowledged but not represented in this assessment.



Map 3.1 Coastal erosion studies - estuary focus

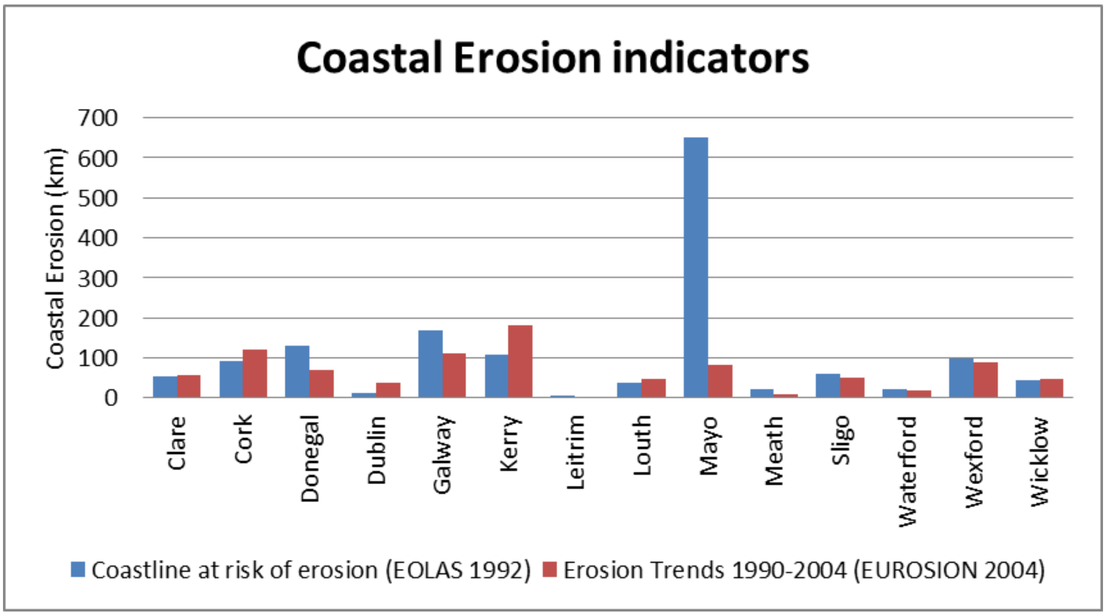


Figure 3.4 Coastal erosion indicators comparison

The other notable difference between the EOLAS and EUROSION studies was specific to County Mayo's coastline as shown in Figure 3.4. In the EOLAS study, most counties estimated more risk than found in the EUROSION study. This applies especially to Mayo where the local authority identified over 600 km at risk, but the EUROSION study identified less than 100 km at risk. This may be partially attributed to the lack of information for 328 km of the Mayo coastline in the EUROSION study.

Overall, the coastal erosion assessment expands the available information beyond the localized information previously available for Ireland. Similar to the other sectors, a full assessment would require consideration of land use changes.

3.1.1.6. Sea Level Rise

Sea level rise exposure required some flexibility due to available datasets because no studies have examined sub-national variations in projected sea level rise. Therefore, this exposure was evaluated with consideration for the likely effects of sea level rise such as coastal flooding and inundation. Three indicators were used: increased storm surges, elevation less than 1 metre, and coastal aquifers.

Storm surge increases were based on climate modelled outputs from the C4I project (Dunne et al, 2008) as discussed regarding flooding. With regard to storm surge, projections were not available from ICARUS in the above described work (Sweeney et al., 2008) or earlier work (Sweeney et al., 2003). Information about sea level rise for the

Irish context was not available. Therefore, storm surge data was used in this research.

The modelled storm surge increase data included three options: increased frequency, 99th percentile change in height, and maximum surge change in height. The 99th percentile change in height was selected for this assessment because the maximum surge data was listed as “more variable and probably not robust” (Dunne et al., 2008:22). There is potential to expand this analysis by using the increased frequency projections as a factor. More detailed assessments are recommended for future comparisons because only thirteen stations were modelled for Ireland as shown on Map A.3 in Appendix A. These stations are spread throughout all parts of the coast with only Leitrim and Louth not represented by a station. Therefore, the value for the nearest station was used (for Leitrim: Donegal's southern station; for Louth: Dublin's station).

This dataset's limitation relates to the few stations. An anomaly in one station may underrepresent the changes anticipated for that area. For example, in Cork City a 0% increase was projected as compared to the others ranging from 2-6%. Therefore, this dataset was used as the best available information; with the caveat of this limitation.

For low lying areas with an elevation less than 1 metre above sea level, the EPA DEM as described regarding landslides was queried for all areas less than one metre above sea level ('low-lying area'). The 1 metre extent was chosen based on the projected rise in sea level of 0.09-0.88 metres by 2100 (Fealy, 2003). These low lying areas are very susceptible to sea level rise because they are generally located directly on the coast. Each county's total low-lying area was calculated in km^2 based on the number of $20m^2$ grid cells within the county's boundaries. In the cases of Sligo and Waterford, a small amount of low lying areas extend inland and these were included rather than using an arbitrary cut-off point.

Coastal aquifers were based on the aquifer dataset of the GSI groundwater resources includes all aquifers (25430) in the Republic of Ireland at a scale of 1:100,000. The dataset was based on GSI Field Surveys conducted between 1845 and 2003, 6” and 1” maps from exploration companies, and field surveys by Universities in Ireland at 6” to the mile where the data is held and maintained by the GSI. According to the GSI metadata: “positional errors of up to 500m have been observed in the datasets that have been used to create the aquifer database" (GSI, 2007). Within the aquifer dataset, each record was classified based on the categories established in the Groundwater Protection

Schemes, which was comprised of four main groups: regionally important, locally important, poor, and locally important karstified bedrock aquifers. The regionally important aquifers include karstified bedrock, fissured bedrock, and extensive sand and gravel. The locally important aquifers include bedrock which is generally moderately productive, bedrock which is moderately productive only in local zones, and sand and gravel. The poor aquifers included bedrock which is generally unproductive except for local zones, and bedrock which is generally unproductive (DELG, 1999). The GSI categorised the 25430 aquifers as regionally important (3167), locally important (8662), poor (generally unproductive) (13059), or unclassified (542). A limitation of this dataset is that it identified the main threat to groundwater from point and diffuse sources without consideration of how climate change will affect groundwater resources.

Of the above described aquifers, 632 regionally important and 2433 locally important aquifers are located in coastal electoral districts. Poor aquifers were not included as they are unproductive as described in Chapter 3. The area of each coastal aquifer was calculated in ArcGIS 9.2 using the Howth's Tools extension.

Similar to the coastal erosion indicators, Clare and Limerick required special treatment for the sea level rise indicators. For Clare, the low elevation areas indicator was calculated using Clare's full county boundary including the estuarine areas. This differed from the coastal erosion sector where no information was included for estuarine areas. For Limerick, a more consistent approach was needed because each county was classed as coastal or non-coastal within this assessment. As stated earlier, based on the lack of coastal erosion data, Limerick was classed as non-coastal for the coastal erosion exposure. Therefore, Limerick was also classed as non-coastal for sea level rise exposure. Although Limerick's exposure to sea level rise is acknowledged in relation to its estuarine areas, Limerick's exposure to sea level rise is not represented within this assessment.

3.1.1.7. Combined physical exposure

As noted previously in Chapter 2, overall physical exposure is the combination of the previously considered climate-related sector exposures, e.g. flooding. Two alternatives were explored for evaluating overall physical exposure: averaging the sectoral exposures and weighting the sectors.

Initial evaluations of the overall physical exposure were prepared using the average of the six sectors. Then, county rankings were derived by dividing them into five categories using the Jenks natural breaks method (as was used for the individual indicators and each sector). These categories were labelled with a range from one (very low exposure) to five (very high exposure). Last, because the physical exposures were evaluated at the county level, the city values were entered using the value of the associated county: Dublin (Dublin City, Dún Laoghaire-Rathdown, Fingal, and South Dublin) and cities with respective counties (Cork, Galway, Limerick, and Waterford).

The results from this initial evaluation benefitted from local and national stakeholder input. Locally, they were included as part of the case study interviews with local authorities (as discussed in Section 4.2.2). Nationwide maps were prepared as well as a county summary sheet for each of the case study councils. Nationally, input from stakeholders in the Environmental Protection Agency and the Department of Environment, Community and Local Government was incorporated into the process from the beginning. The preliminary findings were reviewed by the Irish Environmental Protection Agency as funding agency for this research. The review process by the Environmental Protection Agency included peer reviews by internal staff and external academics. Concerns were raised about the averaging of the sectors, given that national policies favour some sectors such as flooding.

Considering the stakeholder input, a change was made in the methodology. Rather than a simple averaging of the six physical sector exposures, the sectors were weighted based on expert local knowledge. This approach recognises that stakeholders place a higher value on some sectors than others. Alternative metrics to weight the sectors could be based on scientific certainty, economic values associated with adaptations, or a frequency analysis of extreme events, or a comparison of numbers of people affected. After considering the alternatives, expert local knowledge was selected as the best approach.

Information about expert local knowledge had been collected as part of this research through a 2009 nationwide survey of all local authority planners (Details are included in Section 4.2.1). Pertinent to this specific matter, in one question the planners were asked to rate climate-related impacts [increased flooding, water supply (quality/quantity), biodiversity, coastal (erosion/sea level rise), landslides, agriculture, higher temperatures, and other] as 'high impact', 'limited impact', or 'no anticipated impact'. In the 4 responses where this question, or part thereof, was left blank, that response was excluded from this part of the analysis.

Coastal exposures are not equally applicable since seven counties and part of County Dublin are located inland. Therefore, for the weighting of the sectors in the overall physical exposure, each county was classed as coastal or non-coastal, and cities were linked with the coastal/non-coastal status of their associated county. Special consideration was needed for South Dublin County Council located within County Dublin. Given that physical exposures were assessed at county scale where County Dublin included four local authorities (Dublin City, Dún Laoghaire-Rathdown, Fingal and South Dublin County), South Dublin County Council would have been classed as a coastal county even though it is located inland. Therefore, South Dublin County Council's physical exposure was classified as inland and the inland council weighting formula was used.

There were four steps to evaluating overall physical exposure for each county. The first step, weighting of each sector, has four sub-steps as shown in Table 4.1.

a) The value of each response for the sector was calculated by multiplying 'high impact' responses by two, 'limited impact' responses by one, and 'no anticipated impact' responses by zero. Therefore, the sectors with anticipated 'high impacts' were weighted more heavily, 'limited impacts' were represented, and 'none anticipated' had no effect on the sector's value.

b) These values were added together to determine the sector's total value.

c) Total values for all sectors were combined for an overall physical total value.

d) The relative weighting for each sector was calculated by dividing the sector's value by the overall total value.

The second step in evaluating overall physical exposure for each county was to average the weighted values for each sector, based on the stakeholder weighting as shown above in Table 3.3. The formula for coastal counties and inland counties were calculated separately as shown below in Box 3.1.

Table 3.3 Stakeholder weighting of physical sectors

		Sectors				
Councils[1]	Impact levels[2]	Flooding	Water	Biodiversity	Coastal[3]	Landslides
Coastal councils (n=19)	High	30 (15*2)	18 (9*2)	20 (10*2)	28 (14*2)	6 (3*2)
	Limited	4 (4*1)	8 (8*1)	9 (9*1)	5 (5*1)	12 (12*1)
	None anticipated	0	0 (2*0)	0	0	0 (4*0)
	Total	34	26	29	33	18
	Weighting factor	0.243	0.186	0.207	0.236	0.129
Inland councils (n=7)	High	6 (3*2)	8 (4*2)	4 (2*2)	0	0
	Limited	4 (4*1)	3 (3*1)	5 (5*1)	0	3 (3*1)
	None anticipated	0	0	0	0 (7*0)	0 (4*0)
	Total	10	11	9	n/a	3
	Weighting factor	0.303	0.333	0.273	n/a	0.91

[1] Councils include participants in the 2009 survey who indicated anticipated impact levels.
[2] Responses are multiplied by the value listed below for each level shown as number responses (value of response): high impact=2, limited impact=1, no anticipated impact=0
[3] Coastal includes erosion and sea level rise

Box 3.1 Example of physical climate-related exposure

The combined physical exposure formula 1) weighted the sectoral exposures based on local expert knowledge, and 2) averaged the weighted values to form a combined exposure sub-index.

Weighted sector sub-index value = Subindex value * stakeholder weighting value
Combined physical exposure value = Averaged weighted sector sub-index values

FI = Flood sub-index	FW = flood stakeholder weighting
SI = Landslide sub-index	SW = landslides stakeholder weighting
WI = Water supply sub-index	WW = water stakeholder weighting
EI = Erosion sub-index	CW = coasts stakeholder weighting (for erosion and sea level rise)
SLRI = Sea level rise sub-index	
BI = Biodiversity sub-index	BW = biodiversity stakeholder weighting

For example, a coastal county, Clare was calculated as follows:

$= [(FI * FW) + (SI * SW) + (WI * WW) + ((EI + SLRI)* CW) + (BI * BW)]/5$

$= [(2.0*2.43) + (1.7*0.129) + (1.5*0.186) + (3.0+4.3)*0.236) + (2.5*0.207)]/5 = 0.64$

For example, an inland county Carlow as calculated as follows:

$= [(FI * FW) + (SI * SW) + (WI * WW) + (BI * BW)]/4$

$= [(3.0*0.303) + (2.0 * 0.091) + (3.0 *0.333) + (4.0*0.273)]/4 = 0.80$

Third, county rankings were derived by dividing them into five categories using the Jenks natural breaks method (as was used for the individual indicators and each sector). Fourth, the categories were labelled with a range from one (very low exposure) to five (very high exposure).

3.1.1.8. Discussion of physical sectoral methodology

These assessments provided information about sectors as well as combined physical exposures. The sectoral assessments were the building blocks to evaluate how local authorities would be affected by climate change. This part of the assessment, sectoral assessments such as flooding, accomplished three things: placed sectoral exposures already familiar to local authorities in a climate change context, prepared the data so it could be communicated in a visual format for the local authorities, and placed the data into a relative ranking framework to assess the different exposure levels at the local authority scale. The relative ranking framework had benefits and limitations. The two benefits were 1) the comparability of diverse datasets, and 2) the link between the local and national scales. The two limitations were 1) transparency about relative exposures as compared to absolute exposures, and 2) loss of details from the individual indicators when they were aggregated into the sectoral exposures.

With regard to the benefits, the combined physical exposure sub-index brought together the concerns from the different local authority departments related to the 6 sectoral exposures such as the engineer charged with flood protection and the biodiversity officer charged with safeguarding the environment and protecting endangered species. As local authority planners are already required to bring together many different concerns in their policies and decisions on individual plans, this information sought to resonate with their practices and to frame the known concerns in a climate change context.

The two limitations with these results were 1) loss of detail, and 2) absolute versus relative exposure. First, the combined physical exposure ranking obscures the different sectoral components of climate change exposure. Therefore, combined physical exposure should be considered along with the sectoral exposures. Second, regarding absolute versus relative exposures, adaptation is needed even in areas of low relative exposure because the absolute exposure still exists.

Given the foregoing, the results for sectors and overall physical exposures must be considered taking into account these factors. Overall, this part of the assessment evaluated the physical exposures that will affect local authorities, and the next part of the assessment evaluated the adaptive capacity of local authorities.

3.1.2. Evaluating exposure related to adaptive capacity

Adaptive capacity is the ability to moderate potential damage or to cope with the consequences of climate change. This research specifically examined the adaptive capacity of local authorities to contribute to climate change adaptation. Conversely, most researchers have focused on the adaptive capacity of the people living in an area (Adger et al., 2004; Ford and Smit, 2004; Pandey and Jha, 2012; Acosta et al., 2013). Those researchers evaluated adaptive capacity through equity-based indicators (e.g. poverty, gender, and literacy). These metrics would provide limited information about the adaptive capacity of local authorities.

Given that local authorities' adaptive capacity was the focus of this research, appropriate metrics were considered. Similar research has been carried out for this purpose by evaluating development plans and conducting interviews (e.g. Wilson, 2006), surveys (e.g. Allman et al., 2004), and case studies (e.g. Næss et al., 2005). Development plan reviews and surveys allowed for coverage of all local authorities. The interviews and case studies gave more detailed information. A shortcoming of these assessments is that no metric was used to evaluate how resource levels affect adaptive capacity. The second research strand, as described in Section 3.2, included surveys, interviews and case studies.

For this part of the methodology - the climate change vulnerability assessment - adaptive capacity was evaluated based on policy documents (development plans and climate change strategies) and resources. Because there was no existing dataset of climate-related measures among Irish local authorities, the local authority plans were evaluated for the extent that climate change was addressed. All counties have development plans, and some counties have specific climate change strategies. The development plans were used to assess whether climate change had been mainstreamed (the extent that climate change was incorporated into general policies), and climate change strategies were used to assess specific climate measures.

3.1.2.1. Development plans

City and county development plans were used to measure the extent of mainstreaming into the overall strategies by local authorities. This is similar to the work of Wilson (2006) in evaluating UK progress at the local level. To create the development plan dataset, plans were downloaded from the city and county council websites leading up to April 2010 for the preliminary assessment, and in June 2014 for an updated assessment. The preliminary assessment reviewed all development plans adopted between 2004 and April 2010. The updated assessment reviewed all development plans adopted between May 2010 and June 2014. The dataset created and used for the final assessment includes plans adopted between 2008 and 2014. The earliest date plan of 2008 was for Roscommon County Council. The 2008 plan was used as the updated draft plan was subjected to ministerial intervention in July 2014 and the final plan was not made available until the end of January 2015 (Roscommon County Council, n.d.; Roscommon County Council, 2015). Another ten plans were adopted in 2009 and are in the process of being updated with an expected completion date of 2015.

There are strengths and limitations of using development plans for assessing local authority actions. The two strengths are their strategic focus and availability for all councils. First, development plans are the council's overall strategy document for the development and management of the city and/or county. Second, all local authorities have adopted development plans, with updates required every six years by the DECLG DEHLG, 2007a:7). Within the development plans, local authorities acknowledge national policies, set specific objectives and council policies, and describe actions taken to achieve these objectives. In the cases where a development plan references the national policies, the points included and excluded gives information about the local authority's priorities. For example, one local authority may acknowledge the national plan without details, while another local authority may cite details relevant to their local authority agenda, and yet another local authority may set council objectives as well as facilitate these national agendas.

The limitations of development plans for assessing local authority actions relate to omissions (three types), quality, and implementation. The first type of omission: development plans omit detailed requirements since they focus on overall strategy. The second type of omission: internal policies are omitted from development plans. The third of omission, some counties omit climate change from their development plans because they opted to address specific issues in separate policies. Regarding quality, the quality and depths of measures could not be evaluated because of limited details; rather a presence/absence approach was applied. Regarding implementation, as strategic documents, development plans present goals and aspirations rather than a detailed accounting of accomplishments. The information from development plans provides a partial view of climate change mainstreaming by councils.

The plans were reviewed in four stages. First, three plans were reviewed using the 'find' search function for the terms: 'climate', 'global warming', and 'sea level rise'. A separate file for each plan was created which included key phrases. Second, the plans were reviewed for references that were not captured in the first stage. It was found that some actions did not specifically reference climate change; however, had relevance to climate change. For example, one council supported rainwater harvesting, but did not link it with climate change. These actions offer benefits in addressing climate change and, therefore, were deemed important to include within the assessment. Therefore, each of the 34 development plans was reviewed and details were noted about climate change, impacts and adaptations. Climate change provisions included specific references ('climate change', 'global warming', and 'emission reductions') and objectives or policies to address climate change including implementing the National Climate Change Strategy (NCCS). This was a step further than those who only listed the NCCS in the policies they were required 'to have regard for'. Impacts were defined as those identified by previous Irish climate impact research including temperature increases, changes in precipitation patterns, sea level rise, and accelerated coastal erosion as well as sectors likely to be affected including water supply, flood management, agriculture, biodiversity, and marine and coastal environments (Sweeney et al., 2003; Dunne et al., 2008; Sweeney et al., 2008). Landslide impacts were also included based on the association between climate change and landslides as identified by the National Landslides Working Group (Creighton, 2006). These actions included both mitigation and adaptation. Mitigation was defined as those actions that would reduce GHG emissions such as energy usage, transportation and land use patterns. Adaptation was defined as local authority actions that related to the above recognised impacts as well as those with explicit climate change links.

Third, general categories were established for: climate change (explicit references to regulations and projected impacts), energy efficiency, energy renewables, flooding, transport, coasts, biodiversity, water resources, green infrastructure, and carbon sequestration. These results were evaluated and the value for each city and county was calculated using a presence/absence approach. If a development plan included proactive measures related to climate change directly or related to climate change adaptation, the sector was marked with a value of '1'. If a development plan lacked any of these, the sector was marked with a value of '0'.

These results were used in two ways within the vulnerability assessment: First, as a measure each council's proactivity by adding the proactive sectors and using the sum total as the value for each council. Second, as a measure of which sectors were more advanced by adding together the proactive councils for each sector. Council results were then sorted into categories using the Jenks natural breaks method in ArcGIS with the same methodology as used for the physical exposures. An adjustment made where values were sorted from high (more measures) to low (fewer measures) – the councils with the most measures were classed with greatest adaptive capacity and the lowest exposure to climate change. This adjustment was made because exposure related to adaptive capacity is inversely related to the number of measures taken: local authorities with more measures are better prepared and therefore less exposed to climate change.

These results were also used as a starting point to identify the factors that affect local actions. Five factors were analysed for association with more proactive authorities: physical exposure, anticipated impacts, regional affiliation, date of development plan, and population density. Non-parametric correlations were determined by Kendall's tau b (two-tailed tests) which was selected based on the "small data set with a large number of tied ranks" (Field, 2009:181). A p value of <0.05 was considered statistically significant for the analysis. Lastly, the preliminary assessment was updated in June 2014 because 67% of local authorities had adopted new development plans.

3.1.2.2. Climate change strategies

Climate change strategies were used to assess whether local authorities have adopted specific policies to address climate change. This dataset was created as part of this research through web-based searches, a 2011 survey of all local authorities, and telephone calls to the remaining councils. Copies of adopted climate change strategies/drafts were obtained for ten city and county councils as well as two regional groupings. However, during the course of the research it was revealed that some county councils had adopted climate change strategies, but not made them publicly available on the web. Therefore, additional information was collected as part of a survey of all local authorities in November 2011 as described in section 3.2.1. Pertinent to this part of the research, a key question in the 2011 survey was whether the council had adopted and published a climate change strategy. In the cases where respondents indicated the strategy was adopted and published, a copy of the strategy was obtained from each council. In four cases, no information was available on the web or through survey responses, and the council's status was confirmed with the council by telephone.

The local authority progress on climate change strategies was evaluated in two phases: whether they had adopted a strategy, and how advanced the adopted strategies were. First, the progress was categorised, based on the stated objectives and their published strategies, as follows: very low exposure (published draft or strategy), low exposure (completed unpublished strategy), moderate (strategy in process), high (stated objective to prepare a strategy), and very high exposure (no current plans to prepare a strategy). Second, the available climate change strategies were reviewed for details about quantified emissions, reduction targets, and detailed measures. For the purposes of evaluating adaptive capacity and associated vulnerability, this indicator ranks councils based on their progress in adopting a strategy, but does not evaluate the effectiveness or depth of their strategy.

3.1.2.3. Resources

Resources for climate change are not dedicated within local authority budgets or staffing which means that there are no publicly available data sources for this. Ideally, resources for climate change adaptation could be measured using line items in local authority budgets; however, in Ireland, this is not currently in place. In addition, staff allocations have been made at the city or county manager's discretion in each local authority without any climate change requirements (DEHLG, 2010b). Instead, climate change measures fall within the remit of several council departments such as planning, heritage, and engineering. One alternative would be to evaluate resources based on these related sectors. For example, budgets for flood prevention measures would encompass climate change adaptation. Unfortunately, no information is available about how much climate change is addressed within this broader remit.

Even with the above limitations, it was appropriate to apply a metric for resources since they have been shown to affect capacity (Adger et al., 2007). Forward planning staff numbers were selected as a proxy for climate change adaptation resources because this dedicated resource for strategic planning was most closely aligned to future concerns. Planning staff numbers are posted on the DECLG website. This dataset includes the number of total planning staff as well as those dedicated to forward planning. This data set is updated annually which provided information about how planning staff numbers had changed during the course of this research.

While the forward planning staff numbers provide some insight into available resources, there are two limitations: climate change is not the main focus of forward planning staff, and resources are only one factor of adaptive capacity. First, forward planning may, or may not, address climate change based on the local authorities' priorities. Second, even in cases where resources and adaptive capacity are available, this may not translate to adaptation (Tompkins et al., 2010). Therefore, this preliminary analysis of resources only captures part of the relationship between the two variables.

The resources, forward planning staff numbers, were evaluated for the differences by local authority, compared for changes during the research period, and analysed to explore association between resources and actions.

First, the numbers of forward planning staff were compared among the councils and the councils were ranked into five categories using the same methodology as was used for the physical climate exposures. In this case, the values were reverse sorted so that higher numbers of staff members were ranked as lower exposure. This was done for both forward planning staff and total planning staff numbers. In addition, the staffing distribution was compared for total planning staff numbers with the narrower subset of forward planning staff numbers.

Once the data was collected for this step at council level, it was converted into a unit-less scale with five categories as was done with the physical exposures, where indicator values were sorted from low to high so that the councils with the most exposures were classed with the greatest exposure. Conversely, for adaptive capacity, the indicator values were sorted from high to low so that the councils with the most measures were classed with the lowest exposure. This was described in more detail within the earlier methodology descriptions for policies and resources.

Second, forward planning staff numbers were compared for changes during the research period. In addition, the initial assessment used the 2009 figures when preparing for the case studies and interviews. The final assessment used the updated 2012 figures.

Third, forward planning staff numbers (FPS) were analysed for associations between staffing levels and actions taken by local authorities. Kendall's tau was used to compare FPS with 1) the number of added measures in development plans, and 2) the progress in climate change strategies.

3.1.2.4. Discussion about capacity assessment methodology

The adaptive capacity assessment provided information about how proactive local authorities were and explored the role of resources. This assessment provided a baseline of local climate change measures, examined the distribution of measures and local resources, and collected good practice examples.

The assessment had two limitations: 1) limited information about completed actions, and 2) a limited assessment of adaptive capacity. First, limited information about completed actions was discerned from this assessment. Because the development plans and climate change strategies set forth their plans rather than report on their successes and failures, the quality of the capacity could not be fully assessed. Second, this adaptive capacity assessment was limited in scope, depth, and time period covered. The scope focused primarily on planning as a mechanism for climate change adaptation. Limited information was available about other departments e.g. engineering and the entire local authority's potential to facilitate change by the public and businesses. The depth was limited because the assessment was based on published information without internal practices or implementation of their strategic goals. The time period covered was limited to policies adopted between 2004 and 2014. Given that both adaptive capacity and responses to climate change are evolving, with the greatest challenges not yet realised, this assessment was only a starting point.

Even with the foregoing limitations, this adaptive capacity assessment was the first nationwide assessment of climate change actions by local authorities in Ireland. This research extends the knowledge about Ireland's local policies and local authorities' potential to move forward on climate change. At this stage of the assessment, information was still lacking about which Irish local authorities will be most affected by climate change.

3.1.3. Evaluating vulnerability

Each of the foregoing steps contributes to greater understanding about climate exposures in Ireland. Two more steps were necessary to evaluate vulnerability: evaluating sensitivity and impacts, and combining physical exposures and adaptive capacity. First, the analysis moved from exposures to impacts through a sensitivity analysis. The exposures calculated earlier for each county show where Ireland is most exposed to climate-related events and conditions; however, these do not consider the distribution of people who will be affected and the associated climate-related impacts on them. In order to assess how climate change will affect people, the sensitivity analysis in this step incorporated the 2011 Census figures (Government of Ireland, 2012). The exposures were weighted with population density for each city and county from the 2011 Census for each council. This sensitivity analysis was carried out using two alternative weighting metrics: population and population density. Because population density by itself cannot account for all the potential damage to society, future research could incorporate other considerations related to economics, environment, and/or equity. Economic considerations could include critical infrastructure and/or council funding allocations, environmental considerations such as ecosystem goods and services, and equity considerations such as gender, ageing populations and/or poverty.

Second, climate change vulnerability was assessed by combining the physical exposures and impacts (evaluated at county scale) with the exposure and impacts related to local authority adaptive capacity (evaluated at city and county scale). The conceptual framework of this assessment as shown in Figure 3.2 in Section 3.1 (as adapted from Füssel and Klein, 2006) was used to assess the relative climate change vulnerability of Irish local authorities.

Two alternatives were explored for evaluating climate vulnerability: a combined ranking and keeping physical climate factors separate from adaptive capacity. Initial evaluations of climate vulnerability were prepared using an average of the value for each council's adaptive capacity and combined physical factors. Then, the council rankings were ranked in the five categories with the same method used for other steps. These preliminary results were part of the national maps and county summary sheets reviewed by the local authorities in case studies and by the EPA. No changes were suggested by local authority staff members; however, the national stakeholder expressed concerns about combining the physical and adaptive capacity factors. It was recommended that a matrix be used rather than an absolute numerical ranking. Based on this input, a table was prepared with exposure related to adaptive capacity on the vertical axis, and the overall physical exposure on the horizontal axis. A scatterplot was prepared, which shows the specific values for each city and county; thereby, breaking down the aggregated category information.

3.1.4. Discussion of first research strand methodology

This methodology brought together the disparate physical indicators, sectors and adaptive capacity indicators to allow for insights of climate change vulnerability of councils. This methodology places the physical and adaptive capacity exposures in a national context as well as considering impacts where the most people will be affected by climate change. The three main limitations of the first research strand methodology relate to 1) datasets, 2) variations within a local authority for different sectors, 3) relative versus absolute exposures and impacts, and 4) limited knowledge about local authority adaptive capacity. First, the datasets have limitations because they were not designed with a view towards assessing the climate vulnerability. These limitations highlight the informational challenge that local authorities face when planning and adapting to climate change. In addition, the outputs from these datasets must be considered with the caveat that they were created by other entities, such as the GSI staff members, and the data quality has been considered sufficient given that they have been vetted by the national lead agencies and been cleared by the peer review process when considering sources such as the EUROSION dataset. The climate change projection datasets have limitations related to uncertainty associated with modelling future processes and complex interactions between the different physical and socio-economic components. Therefore, these datasets were used for an initial assessment of climate change vulnerability of Irish local authorities and as a starting point for discussions with local authorities rather than to advise specific plans.

Second, because the details of individual parts of the assessment are aggregated into simplified values, local authorities might be inclined to only consider the simplified value. This course of action would be ill-advised because their actions based on this one value would likely be insufficient in one or more areas. For example, if a local authority were to base adaptation decisions solely on their assessed very low climate change exposure or impact, this would leave them ill-prepared for climate change with regard to sectors where they had very high exposure or impact.

Third, because each local authority's exposure and impact values are placed within a national relative ranking, local authorities might be inclined to consider the relative exposures or impacts in lieu of their absolute exposures or impacts. This course of action would be ill-advised because actions based on their relative ranking would likely be insufficient when considering their absolute exposures or impacts. For example, if a local authority were to base their adaptation decisions solely on their very low exposure or impact ranking, this would leave them ill-prepared to deal with the effects of climate change that did occur in their jurisdiction. Therefore, even a very low ranking requires planned adaptation to climate change. Fourth, even though this research advanced the knowledge about local authority adaptive capacity, much remains to be explored about completed actions, internal practices, and input from other departments within local authorities beyond the planners.

3.2. Second research strand – exploration of adaptive capacity

The climate change vulnerability assessment provided a starting point which was expanded in the second research strand to access internal practices and cross-departmental input within local authorities. The previously analysed material did not explain why some local authorities were more proactive than others. It suggested that local circumstances were affecting progress on climate measures, and raised the question of whether the local circumstances were driving climate measures or whether national requirements were the key drivers. To help answer this question, the surveys were analysed more extensively, and case studies and higher level interviews were carried out.

3.2.1. Survey design and execution

Beyond the publicly available data for resources and policies, information about internal measures by local authorities was lacking. To fill this information deficit, nationwide surveys of all city and county local planning offices were carried out in 2009 and 2011. The 2009 survey focused on local planners' perceptions about climate change impacts, barriers to adaptation, and existing municipal responses. The 2011 survey sought to update information from the 2009 survey and, in addition, focused on climate-related actions and barriers to those actions. These surveys included questions adapted from other international surveys to facilitate comparison between local authorities in Ireland and other countries about:

- mainstreaming climate change into council practices and policies (UK: Local Government Association, 2007; Scotland: Matthews, 2005),
- impacted sectors, status of local risk assessments, and information needs (Australia: Local Government and Shires Association New South Wales, 2006),

- challenges (England and Wales: Allman et al, 2002; Scotland: Matthews, 2005),
- useful information sources (England and Wales: Demeritt and Langdon, 2004),
- anticipated impacts (Scotland: Matthews, 2005), and
- good practice examples (Australia: Local Government and Shires Association New South Wales, 2006; Scotland: Matthews, 2005).

Part of the survey design included selecting the participants. Planners, environmental awareness officers, and county managers were considered. Planners were selected as the best source of knowledge about addressing climate change within local authorities' policies and practices. Environmental awareness officers have a more limited range of responsibilities in Ireland and would be unlikely to comment on how strategic plans were being formed on long-term issues such as climate change. County managers were deemed less likely to participate in the survey.

The 2009 survey was piloted with one council's senior planner who had showcased his council's proactive measures in a 2009 nationwide climate change conference for local authority planners. Input was received regarding the survey content, dissemination methodology, and length; and minor changes were made. The finalised survey included 15 questions requiring short answers and ticking boxes; respondents were given the opportunity to supplement their answers with additional information. All 34 councils were contacted by telephone to identify the person in the planning department who was familiar with the current development plan and related climate change issues. The questionnaire was disseminated by email and post during the summer of 2009 with follow-up contacts during the autumn.

The 2011 survey built on the information from the earlier survey. The surveys were sent to respondents from the 2009 survey for each council. The questionnaire was disseminated by email and post in early November 2011 with follow-up contacts during December. The collected data was then used to update the status of councils on proactive measures, and compare perceptions of impacts and challenges between 2009 and 2011. Similar to the 2009 survey, participants were assured of confidentiality and results are presented without individual responses being linked with specific county councils. Copies of the 2009 and 2011 surveys are included in Appendix E.

The survey responses were analysed for several key themes: perceived exposure/vulnerability, types of local actions, challenges to adaptation. The perceived exposure/vulnerability was assessed for the sectors and responses were compared from 2009 and 2011 responses.

The types of local actions were grouped into mainstreamed measures, risk assessments, and good practice examples. The mainstreamed measures were analysed with a focus on the types and numbers of sectors addressed. The risk assessments were analysed by type and results were compared with a survey from New South Wales (Local Government and Shires Association New South Wales, 2006). The good practice examples were examined for types and numbers cited by local authorities.

The challenges to adaptation were analysed for prevalence, grouped by types of challenges, and analysed for changes over time. The prevalence of challenges was an important factor to consider because widespread measures would suggest that these challenges were pervasive and likely unrelated to local circumstances. The types of challenges were important because grouping them into three broad types offered a way to examine possible solutions. Lack of resources was identified as a key challenge in advancing climate measures (Allman et al., 2004; Betsill and Bulkeley, 2004; Sygna et al., 2004; Lankao, 2007; Hanak et al., 2008; Puppim de Oliveira, 2009). Competing priorities evolved as a type of challenge through the analysis. Integration challenges represent governance shortfalls and related to horizontal integration and vertical integration. Horizontal integration refers to barriers within the local authority and between the local authority and the general public. Vertical integration refers to barriers resulting from shortfalls in a coordinated approach between local authorities and higher government levels.

These surveys gave information about the internal practices and challenges faced by local authority planners. The high response rate provided good coverage of the local authorities even though responses yielded limited information about what drives local climate change adaptation. The other main limitation of the survey responses was a lack of information about how other local authority departments were addressing climate change. In order to further advise the conclusions to be drawn from this study, more information from the local authority staff members was needed. In addition, based on vertical integration being identified as a key challenge, information was needed from higher government levels to place the local authority actions in context and to explore whether further drivers were likely to come from higher government levels.

3.2.2. Case studies

Building on the information that was collected from all local authorities, case studies were carried out to obtain expanded information about the challenges to local climate change adaptation. The lack of information about Irish local authorities in published research, and limited details provided in the surveys, required these additional steps to help explore the factors that affect local authority adaptation.

3.2.2.1. Case studies in other jurisdictions

Case studies are an appropriate methodology to go beyond written policy statements and to explore the details policy design and implementation (Yin, 2009). They have been used by other researchers to explore local climate change measures (Bulkeley and Betsill, 2003; Granberg and Elander, 2007; Gustavsson et al., 2009; Burch, 2010). Bulkeley and Betsill (2003) used six case studies from the UK, US and Australia which were developed through three different research projects in 1998-2002. These case studies focused on mitigation, climate policy development, and sustainability. The researchers limited their candidates to members of the International Council for Local Environmental Initiatives Cities for Climate Protection Campaign. Granberg and Elander (2007) examined the progress of Swedish municipalities for climate mitigation and adaptation. Based on findings from 2 surveys, they concluded that larger municipalities were more active than smaller ones. The extended their research with a 2005 study of four municipalities that addressed both mitigation and adaptation. They included municipalities who had in "common a proximity to the sea, lakes or rivers and two of the municipalities had also recently experienced extreme weather conditions causing flooding and damage of infrastructure and economy. All four had also recently completed their outline plans following the Building and Planning Act, which calls for municipalities to include and account for environmental and other risk factors" (Granberg and Elander, 2007:544). Two further case studies of Växjö and Sundsvall in Sweden evaluated the role of networking and local circumstances as influencing factors for local climate measures (Gustavsson et al., 2009).

3.2.2.2. Case study purpose

The initial purpose of the case studies was to gain understanding and information about actions that were taking place where information was not in the public domain. These case studies were also a forum to pilot the vulnerability assessment information. Within this research, the assumption was that climate change related activities were occurring as part of other policy agendas. Such practices varied among local authorities. For example, even though all local authorities had incorporated Sustainable Urban Drainage Systems into their county development plans, there were differences in how extensively these measures were incorporated.

In addition, further information was sought about how the local authority staff members viewed their individual roles in adapting to climate change and how their internal structures worked or not to address climate change. This information was sought in order to better understand what drives climate change measures. The case studies facilitated insights on the local authorities studied; they do not represent a comprehensive description of all circumstances in Irish local authorities.

3.2.2.3. Case study selection

The case studies focused on four local authorities that were selected based on the following criteria: 1) urban and rural, 2) coastal and inland, 3) different regions, 4) high and low physical exposure, and 5) high and low adaptive capacity. Urban or rural conditions were considered important because Ireland has a dispersed population and less is known about rural communities because many researchers have focused on cities (e.g. Bulkeley and Betsill, 2003). Coastal or inland location was considered important because coastal counties are exposed to erosion and sea level rise, which are not challenges for inland counties. The climate change exposure for each county was compared in two ways: with all sectors included and with only non-coastal sectors as shown in Figure 4.5. Based on this comparison, including an inland county was deemed very important because most inland counties had lower relative climate change exposure. The relative vulnerability criteria included relative hazards exposure and adaptive capacity exposure as shown in Figure 3.5. These exposure and vulnerability rankings were based on the initial assessment completed before 2010, and the final assessment results differed from these. Four case studies were planned to include proactive and laggard counties.

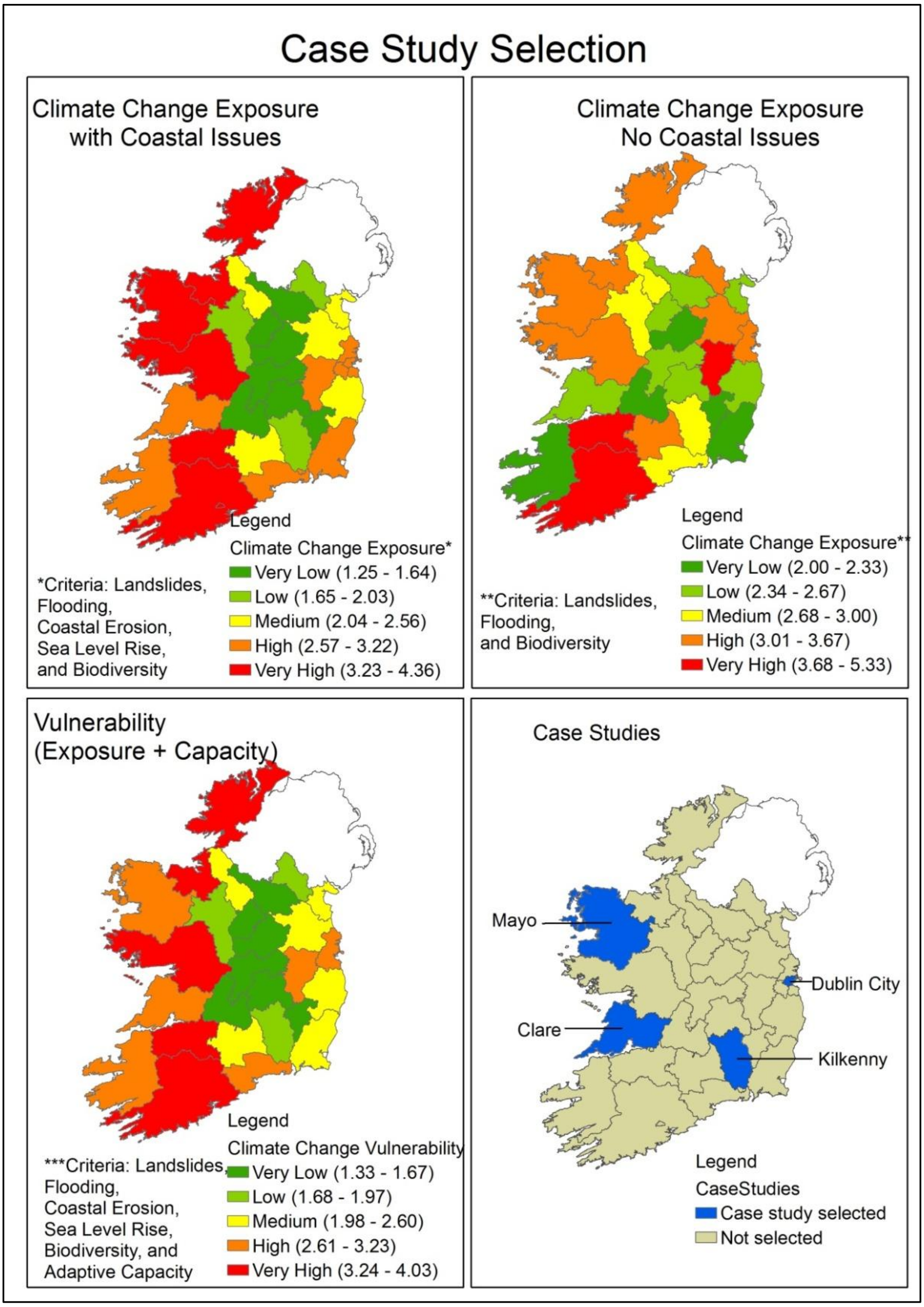


Figure 3.5 Comparison of exposures for case study selection.

A pilot case study was carried out to test the methodology. Mayo County Council ('Mayo') was selected as a useful case study within the context of the risk matrix proposed by Aall and Norland (2005) because of its high climate vulnerability due to high physical exposure and low adaptive capacity. The high physical exposure relates to high exposure for hazards (landslides and inland flooding) as well as coastal issues (erosion and sea level rise). The low expressed capacity relates to no current plans for a climate change strategy, few added measures in the county development plan, and a low number of forward planning staff. Mayo County Council was also selected to explore issues regarding challenges in implementing measures at the local level. For example Mayo's Senior Planner, speaking at the Landslides Workshop hosted by the Geological Survey of Ireland in 2009, reported that one-off homes have been built in areas prone to landslides in the past and there has been considerable resistance to refusing planning applications in these areas. This pilot case study provided information regarding the challenges local authorities were facing. It also allowed for early adjustments in the research design. After the pilot case study, it was deemed more useful to focus on the proactive local authorities' progress to gain greater insights into how proactive local authorities were overcoming challenges.

The other case studies included Dublin City Council ("Dublin") and two other case studies. Dublin was selected as a case study because it is the capital city and the greatest population centre. In addition, the development plan review included proactive climate change measures, e.g. a climate change strategy and flood management policies.

The remaining two case studies were selected based on the previously described criteria and availability of the local authority staff members. First, local authorities who did not participate in the survey were excluded. Second, several local authorities were contacted as potential case study candidates based on the previously described criteria. Using these considerations, seven local authorities were considered as case study candidates (shown in Table 3.4).

The final case studies were selected to include an inland county and based on climate change vulnerability (as shown in Figure 3.5 in the bottom left panel) with the intent to include a county with high and low climate change vulnerability. Kilkenny County Council ("Kilkenny") was selected as an inland county that also had low vulnerability, and Clare County Council ("Clare") was selected as a county that had high vulnerability, with the added consideration that it was another rural county in the west of the country.

Table 3.4 Case study candidates and selection criteria.

	Urban/Rural		Coastal/Inland		Regional Authority								Physical Exposure					Adaptive Capacity Exposure				
Candidate	Urban	Rural	Coastal	Inland	Border	West	Midlands	Mid-East	Dublin	Mid-West	South-West	South-East	Very low	Low	Moderate	High	Very high	Very low	Low	Moderate	High	Very high
Carlow		■		■								■	■							■		
Clare		■	■							■						■						
Dublin City	■		■						■							■		■				
Kilkenny		■		■								■		■								
Laois		■		■			■						■							■		
Mayo		■	■			■											■		■			
Offaly		■		■			■						■					■				

The final case studies selected included a range for the above criteria. The results from the initial vulnerability assessment are included here for reference. The local authorities selected for case studies were similar in some ways and different in others. The key points include: overall climate vulnerability and different sector exposures. The overall climate vulnerability varied among each of the local authorities as shown in Table 3.5, with physical exposure ranging from moderate (Clare) to high (Kilkenny and Dublin City) to very high (Mayo). The adaptive capacity exposure ranged from very low (Clare and Dublin City) to moderate (Kilkenny) to high (Mayo). The information presented within this section was based on the initial assessment in 2009. These are different from the final assessment report in Chapter 6 final results for the vulnerability assessment.

Table 3.5 Overall climate change vulnerability factors

		Physical climate change exposure				
Exposure related to level of adaptive capacity	Very high					
	High					Mayo
	Moderate				Kilkenny	
	Low					
	Very low			Clare	Dublin City	
		Very low	Low	Moderate	High	Very high

In reviewing the different sector exposures, the selected local authorities included a range for each of the sectors. Table 3.6 shows both exposure and impact, Table 3.7 shows exposure with very low exposure on the left and very high exposure on the right. It was anticipated that each local authority would have added policies or measures for the sectors with high or very high exposure.

Table 3.6 Vulnerability ranking of case study local authorities

Case study local authorities' categories by sector is listed by exposure (impact)								
	Flooding	Landslides	Water Supply	Coastal Erosion	Sea Level Rise	Biodiversity	Combined Physical	Adaptive Capacity
Clare (CE)	2 (1)	2 (1)	1 (1)	4 (1)	5 (1)	2 (1)	3 (1)	1 (1)
Dublin City (D)	5 (5)	2 (5)	4 (5)	2 (5)	3 (5)	5 (5)	4 (5)	1 (5)
Kilkenny (KK)	3 (1)	1 (1)	3 (1)	n/a	n/a	5 (2)	4 (1)	3 (1)
Mayo (MO)	5 (1)	5 (1)	4 (1)	5 (2)	4 (1)	2 (1)	5 (1)	4 (1)

Table 3.7 Local authorities' sectoral exposure

Flooding		Clare	Kilkenny		Dublin City Mayo
Landslides	Kilkenny	Dublin City Clare			Mayo
Water supply	Clare		Kilkenny	Dublin City Mayo	
Coastal erosion		Dublin City		Clare Mayo	
Sea level rise			Dublin City	Mayo	Clare
Biodiversity		Clare Mayo			Dublin City Kilkenny
Combined physical			Clare	Dublin City Kilkenny	Mayo
	Very low	Low	Moderate	High	Very high

The 2010 status of measures and allocated resources is detailed below in Table 3.8. Both the descriptor and the exposure ranking are included for each factor, as well as for the overall adaptive capacity exposure. These rankings are within a national context and, therefore, even though a local authority falls within very low or low exposure ranking for individual factors, when these factors are averaged, its status for adaptive capacity overall may fall within a different category.

Table 3.8 Current status of measures related to adaptive capacity

	Clare	Dublin City	Kilkenny	Mayo
Added measures	5 measures	6 measures	6 measures	2 measures
	Low exposure	Very low exposure	Very low exposure	High exposure
Climate change strategy	Strategy published	Strategy published	Strategy adopted	No current plans
	Very low exposure	Very low exposure	Low exposure	Very high exposure
Number forward planning staff	16.1	23.8	3.0	6.7
	Low exposure	Very low exposure	Very high exposure	High exposure
Overall Adaptive Capacity	.27	.20	.53	.87
	Very low exposure	Very low exposure	Moderate exposure	High exposure

3.2.2.4. Case study execution

Information in each case study was drawn from policy documents and semi-structured interviews. The policy documents were collected through web-based searches of the selected councils' websites, associated Regional Authorities' websites, the Irish Times database, and a general Google search using terms for the vulnerability assessment sectors and more general terms including 'climate change', 'adaptation', 'spatial planning', 'transportation', and 'global warming'.

Semi-structured interviews were conducted with local authority staff members after the preliminary vulnerability assessment was completed. Dates were arranged through letters and telephone calls detailing the research and requesting interviews with the manager and other key staff members, including: county managers, senior planners, climate change team members, engineers, energy agency managers, environmental awareness officers, heritage officers, county development board members, and county councillors. Details about interviewees are included in the Results Chapter Section 7.1.

Mayo staff members were interviewed in April 2010. Dublin City, Clare, and Kilkenny staff members were interviewed during May and June 2010 at the council offices in group interviews. In each of these cases, notes were taken during the interviews and transcribed afterwards.

The local level interviews were designed to facilitate additional insights beyond the published policy documents. The questions focused on four themes, as identified from the 2009 survey responses, which are listed below:

- Measures beyond policy documents
- Organisational challenges within the local authority departments
- How central government can support local adaptation
- Synergies between other policy objectives and adaptation.

A detailed list of questions is included in Appendix G. In addition, the preliminary results from the climate change vulnerability assessment were available for the interviews in each case study. These results include national assessment maps for the sectors as well as a county summary sheet for the relevant local authority. The questions for this portion of the interviews were less structured, with providing the information to the interviewees and gaining their insights regarding how useful the information would be as they prepare for climate change.

Following the interviews, general information provided in the interviews were subsidised by information from further review of local policy documents and web searches regarding the specific local authorities. For example, Dublin City interviewees mentioned network participation, but did not provide specific details.

Once all the case study interviews were completed, an analysis of the interviewees' statements was carried out to draw general influences about the different local authorities' approach to preparing for climate change. Within this analysis, themes were identified, the distribution between challenges and opportunities discussed, and the council's ethos as they responded to higher level policy requirements, local events, and implementation challenges.

3.2.2.5. Discussion re: case studies

These case studies advanced the knowledge about internal practices, and conclusions must be tempered by the following limitations: sample size, narrow time frame, and the participating individuals. While the limitation of the sample size was offset by the criteria of case study selection, it is acknowledged that each local authority has a unique mix of priorities, circumstances, and personnel. In addition, within the case studies, interviews were not possible with all individuals serving in the local authorities. This limitation was offset by seeking participation from staff members in a broad range of roles. The narrow time frame of the case studies offered a snapshot of local authority experiences. Repeated case study findings would be affected by the evolving policy context, changing economic circumstances, and climate change impacts. The participating individuals affected the findings based on the situated experience of the interviewees and researcher. Staff members were interviewed in their official capacity (e.g. planners), and their responses spoke to these responsibilities and concerns. At the same time, personal perceptions and experiences inevitably colour these professional responses. Similarly, the researcher's situated experience as a female, doctoral researcher inevitably coloured the interactions with the interviewees as well as the interpretation of the findings. This limitation was offset through clear communication of the research focus, and preparatory research about the local circumstances of the study area by location and subject matter. These limitations reflect inherent challenges in conducting research, and they are included primarily to acknowledge them.

These case studies yielded information about the local authority practices and perceptions regarding the climate change challenges, completed actions, and potential ways to move forward on climate change. The case studies also yielded information about the local circumstances that affected local authority adaptation – both positively and negatively. Based on the case studies' input, further information was needed about higher level plans to address climate change at the national and local levels.

3.2.3. Higher level input

Higher level input from Regional Authorities and from the national DEHLG provided context for the local authorities' input. Information at higher levels included review of policy documents and semi-structured interviews. The policy documents were collected through web-based searches of the selected authorities' websites.

Semi-structured interviews were conducted with regional authority and national government staff members after the case studies were completed. Dates were arranged through letters and emails detailing the research and requesting interviews. In each case, notes were taken during the interview and transcribed afterwards. The interviewees were selected to examine the context in which the case study local authorities were operating. Further, these interviews with regional authority and national government staff members explored plans to advance climate measures at all levels.

3.2.3.1. Regional level

The purpose of the regional level interviews was to explore the role for regional government to coordinate and facilitate local government climate measures. Potential has been shown in other countries such as Germany with its regional approach to climate change. Conversely, Irish regional authorities were characterised as weak (Boyle, 2000; Quinn, 2003) and there was no publicly available information about regional climate-related actions. The current research engaged with regional authorities for three reasons: 1) to explore the validity of reported limitations, 2) to explore the potential of regional authorities to drive local climate measures, and 3) to explore the connections between subnational and central government.

First, regional authorities were severely under-resourced even as national government stated an intention to increase the powers of regional government (Chapter 2). The 2014 amalgamation of the 8 Regional Authorities into 3 Regional Assemblies leaves the future role of this mid-level tier of government unclear.

Second, preliminary findings suggested regional authorities might be advancing climate measures beyond what was already published in the literature. Preliminary findings from the development plan review showed that local authorities in the South-East Region were more proactive than local authorities in other regions with regard to climate change. This preliminary finding contrasted with findings in Brazil’s river basin management where governance capacity varied even within individual districts (Engle and Lemos, 2010). In addition, preliminary findings from the case study interviews showed that the South-East Region Authority was coordinating and facilitating sustainability and climate-related measures. These preliminary findings prompted exploration of Regional Authorities' potential to drive local climate measures. Third, the weak connection between local level policies and national objectives, as suggested by the 2009 survey responses, illustrated an implementation gap that might be lessened through coordination by Regional Authorities.

Two regional authorities were examined with a review of their published documents and through interviews. The published documents reviewed included Regional Planning Guidelines and Annual Reports. The regional level interviews focused on the Regional Authority and its role in advancing sustainability and preparing for climate change (a detailed list of the interview questions is included in Appendix G). The regional interviews were premised on central government acknowledgement of the importance of the regional planning guidelines. These regional authorities were selected based on the local authority case studies: the South-East Regional Authority (associated with Kilkenny) and the West Regional Authority (associated with Mayo). The South-East Regional Authority's Director was interviewed in May 2010 at the Regional Authority offices. Regarding input from the West Regional Authority (associated with Mayo), an interview was scheduled with the Director; however, he was unavailable on the day. At the time of the interview in June 2010, one staff member was in the office and had prepared for the interview. This staff member had been with the Regional Authority for the past year, and was involved with the Galway County Development Plan reviewed by the Regional Authority. Follow up questions were emailed to the West Regional Authority, and the further responses were included as part of these results.

The limitations of the regional input in this research related to number of interviews and types of regional entities. The two interviews facilitated some insights, and future research could include further interviews with other Regional Authorities for spatial planning and for other sectors such as River Basin Management Districts.

3.2.3.2. National level

At the national level, four senior officials of the Department of the Environment Heritage and Local Government (DEHLG) were interviewed (a detailed list of the interview questions is included in Appendix G). These interviewees were selected based on recommendations from initial contacts with DEHLG staff members. First, a recommendation was made during the stakeholder input by the DEHLG as referenced in Section 3.1.1.7, and successive interviews were based on recommendations from each interviewee. In November 2009, a DEHLG high-level official was interviewed to explore the links between central government policies and local government implementation. This person was selected because he was meeting with all Regional Authorities during that time and was instrumental in revisions of Regional Planning Guidelines and the National Spatial Strategy. The input from this interview was used for context but not formally analysed.

In June and July 2010 (after the subnational interviews were completed), the DEHLG's Principal Officers for the Climate Policy Unit and the Local Government Policy Unit were interviewed at their offices for their convenience. The interviews were designed to add to the knowledge base in three areas:

1) to share the input from the local authorities,

2) to explore national government staff members' perceptions beyond what is evident in the policy documents, and

3) to explore opportunities and challenges relevant to their specific areas. The Central Policy Unit interview focused on the central government's plans for addressing climate change. The Local Government Policy Unit interview focused on the central government's plans for local level implementation of climate change policies.

In April 2012, the previous Minister for the Environment (who held office during the years 2007-2011) was interviewed in a public venue at the interviewee's request. The core themes identified for this interview were as follows:

- challenges regarding vertical and horizontal integration
- challenges making a transition from high-level strategies to practical implementation
- opportunities to move forward within the current framework
- opportunities that could be realised if there were greater support from the public and the elected officials

The national level interviews allowed for some insights about horizontal integration challenges within the Department of the Environment. The conclusions drawn about national government were limited by lack of consideration of other Departments, interview limitations, and the evolving national policies. Limited information was obtained about broader integration with other Departments and remains an area for further research. Further, the limitation of drawing conclusions based on four interviews is acknowledged regarding individuals interviewed and time covered. As discussed in relation to the case study interviews, the findings are presented with the cautionary note that input from other individuals would likely include a different set of perceptions. In the case of the national level interviews, it is acknowledged that senior officials have extensive experience in limiting their disclosure of unfavourable information. Early in their interviews, both Principal Officers confirmed their responses were 'on the record'. The interviewees' awareness (that their comments would be made publicly available) was further revealed during the interview with the Principal Officer of the Local Government Policy Unit. Once the majority of the interview was completed, an opportunity for the Principal Officer to reflect 'off the record' was offered, and it was accepted. Accordingly, the ensuring commentary was not used in an official capacity. The discrepancies between the interviewee's official responses and personal opinions made clear the limitations of conclusions drawn solely from interviews. Similarly, the interview with the previous Minister for the Environment was held in a public setting at the interviewee's request as noted earlier. Therefore, even though the commentary of a person no longer in office is more likely to provide a fuller picture, this input must be considered with this caveat. In addition to the limitations related to the interviews, the recent changes in national policies are only beginning to be reflected in local authority policies and practices.

3.2.4. Discussion about second research strand methodology

The second research strand moved beyond the published documents and explored internal local authority practices, factors that affect local authority adaptation, and potential for more widespread local authority adaptation. This information yielded diverse results from the different participants that confirmed climate change as a wicked problem without a neat definition of how to advance local authority climate change adaptation. The main focus of this research was on local authorities as the research aims were to assess the ways that climate change will affect Irish local authorities and to identify how adaptation deficits can be fixed through a greater understanding of related governance issues. The input from higher levels could be expanded to provide more information about future plans and actions from other Departments.

3.3. Methodology discussion and conclusion

To address the Aims and Objectives, this research used a broad range of methods, which included a climate change vulnerability assessment, analysis of local authority plans and strategies, surveys, case studies and interviews. This combination covered the physical climate change exposures as well as the adaptive capacity of Irish local authorities. Each of these methods had benefits and limitations as discussed throughout this chapter. When considering the cumulative effect and interactions between these methods, two key points merit discussion prior to the results presented in Chapters 5-8: first, connecting local and national scales and, second, the usefulness of the climate change vulnerability assessment.

First, connecting local and national scales was a focus of this research both regarding the vulnerability assessment and in exploring factors that affect local authority adaptation to climate change. The success of the vulnerability assessment was mixed due to the limitations of relative ranking methodology. This assessment was designed to assess the exposures and impacts as well as to communicate the findings to local authorities. The assessment of exposures and impacts provided a broad brush examination that would require further refinements in order to advise adaptation plans. The success of the multi-level exploration of factors that affect local authority adaptation to climate change yielded more fruitful results. The complexity of the different drivers was explored as well as a range of potential ways to increase the widespread adoption of climate change measures.

Second, the local authority climate change vulnerability assessment had limitations as far as usefulness to local authorities. Case study interviewees expressed a range of interest in the preliminary findings. Some engaged fully, while others were more intent on promoting their proactive measures rather than discussing climate change. A challenge of the methodology was striking a balance between breadth and depth. In some cases, a broader address of a sector such as biodiversity was sought e.g. including all flora and fauna as well as Red Listed species. In other cases, more detailed information on landslides events was sought e.g. the national landslides database records did not include all known landslides in Mayo. In all cases, the preliminary maps presented for discussion seemed to confirm information already known to the local authority staff members. Even so, the preliminary maps prompted discussions about climate change exposures and possible adaptations.

Overall this methodology was an effective approach to achieving the Research Aims and Objectives. Aim 1 was to assess the ways that climate change will affect Irish local authorities. This was accomplished through the Climate Change Vulnerability Assessment that addressed Objective 1 which was to identify city and county councils that face greater challenges association with climate change than other local authorities in Ireland. In addition, the Development Plan Review, Surveys, and Case Studies addressed Objective 2 which was to identify good practice examples and adaptation deficits by Irish local authorities.

Aim 2 was to assess the factors that affect adaptation by local authorities. This was accomplished through the surveys, case studies, and higher level interviews. These three methods addressed Objective 3 which was to identify how adaptation deficits can be fixed through a greater understanding of related governance issues. The inputs from these sources facilitated good insights into the challenges from the perspectives of government civil servants and senior officials. The insights about the full extent of effective governance were limited within this research. Drawing broader conclusions about local climate change governance would require engagement with the private sector. While the benefits of this extended focus are recognised, a more in depth examination of the government sector was deemed appropriate for this study. Therefore, the results presented about effective climate change governance must be considered in light of this limitation.

The merits and limitations of the findings from each part of the methodology are examined in the results chapters that follow. The results from the First Research Strand are reported in Chapters 5 and 6. Chapter 5 presents the results from the Development Plan Review separately from the Climate Change Vulnerability Assessment. This research was carried out as part of the first research strand and yielded extensive information about local authority measures that had not been evaluated previously. Chapter 6 presents the results from the Climate Change Vulnerability Assessment. This research was also part of the first research strand and provided the baseline information of how climate change will affect local authorities in Ireland. The assessment yielded information about the ways that climate change will affect Irish local authorities that had not previously been available in one format.

The results from the Second Research Strand are presented in Chapters 7 and 8. Chapter 7 presents the Survey Results which were conducted as part of the second research strand and provided information about measures by local authorities, challenges affecting adaptation, and perceptions about how climate change will affect local authorities. These results present findings from the first nationwide surveys of local authorities regarding climate change. Chapter 8 presents the findings from the Case Studies and Higher Level Interviews which were conducted as part of the second research strand. These results provided information about internal local authority practices and administrative challenges affecting local authority climate change adaptation.

Chapter 4. Development Plan Review

4.1. Introduction

The results presented in this chapter represent a new dataset that was created through this research, since no comprehensive dataset about local authorities' preparations previously existed. Local authorities have mainstreamed climate change into their development plans to varying degrees. This chapter examines the number of measures, the sectors addressed, and the types of measures.

4.2. Number of climate-related measures

The number of climate-related measures increased when comparing plans adopted up to 2010 with plans adopted between 2010 and 2014 as shown in Figure 4.1. In the first period with development plans adopted between 2004 and 2010, local authorities addressed climate change in an average of 4 sectors (range: 1 to 8 measures). Laois included the fewest (1 sector), and Cork City included the most (8 sectors).

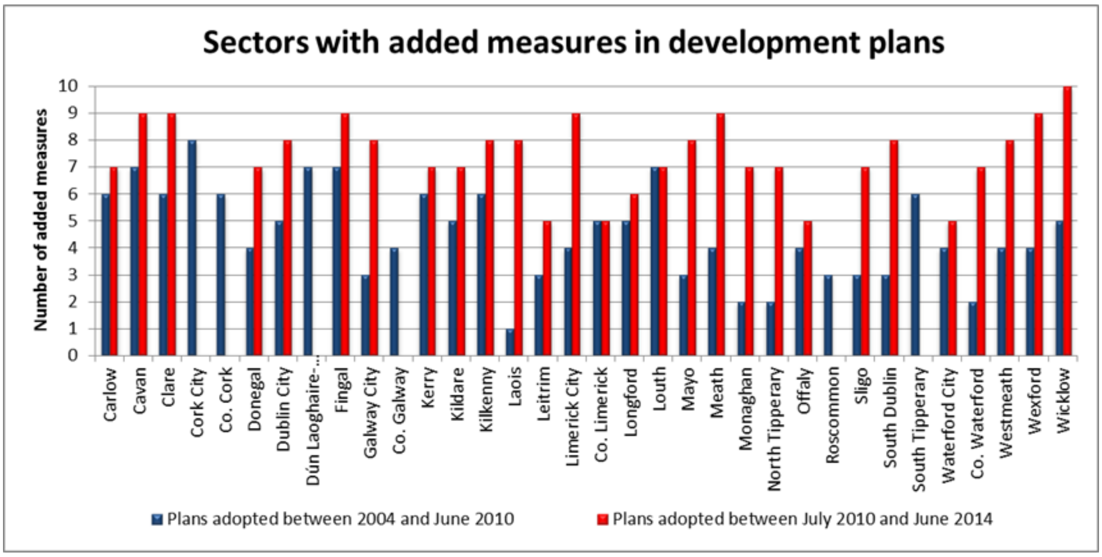
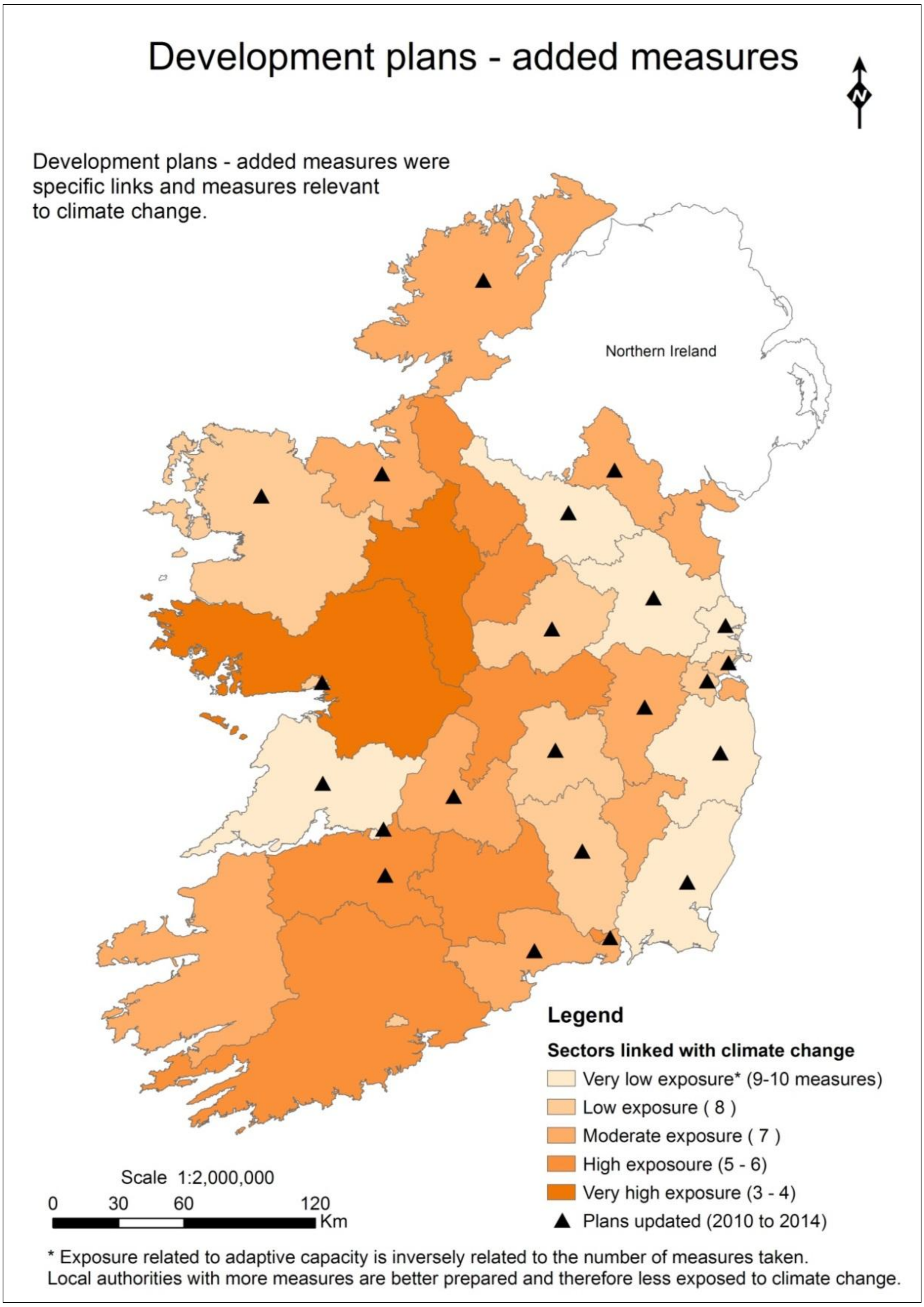


Figure 4.1 Development plans added measures as of 2010 and 2014

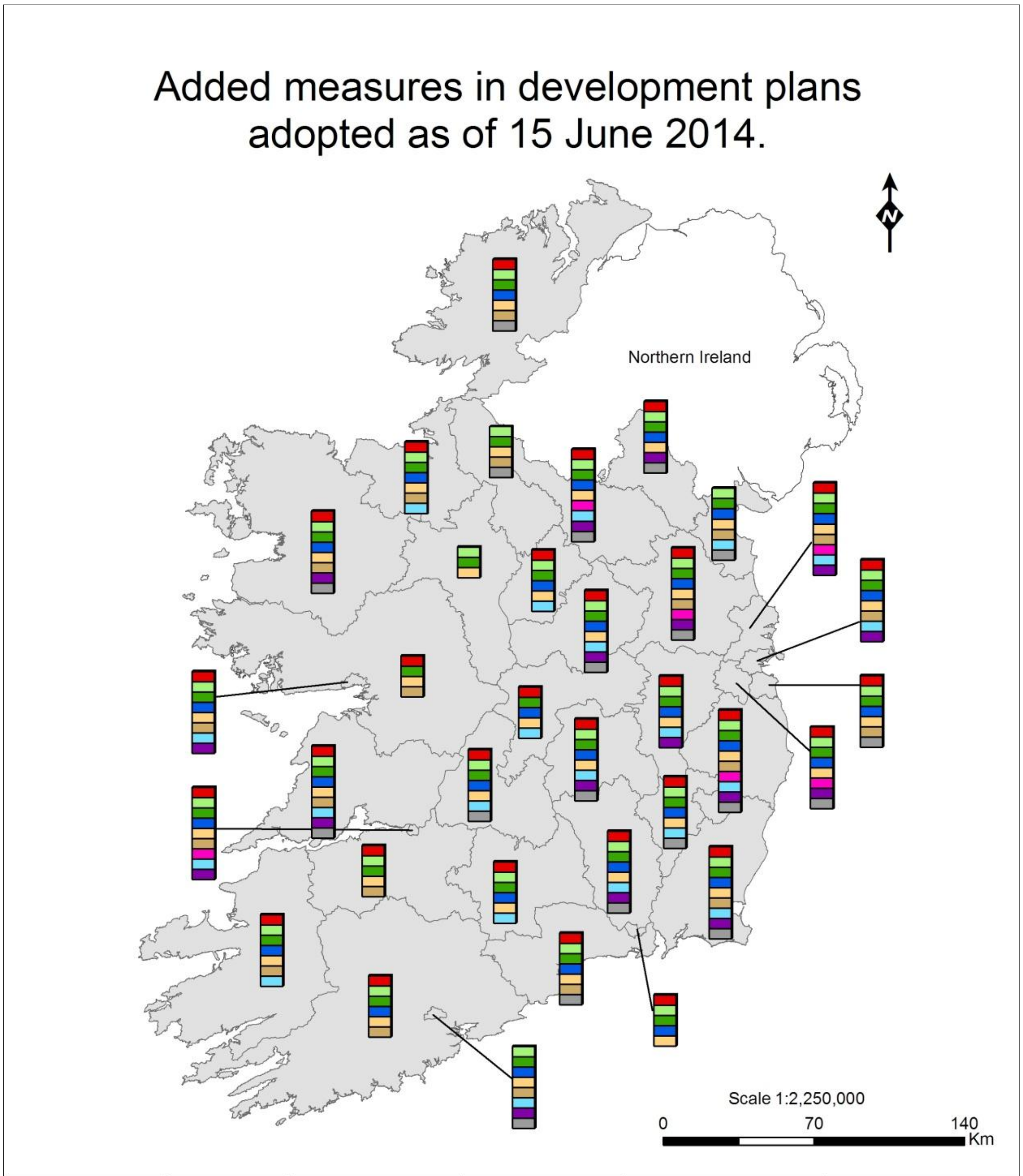
When the earlier plans (those adopted between 2004 and 2008) were updated, the number of sectors addressed increased. After 2010, local authorities addressed climate change in an average of 6 sectors (range: 3 to 10 measures). These increases were greater in some plans than others: eight plans had not been updated and are not due to be updated until 2014 or later, thirteen increased by a 1 to 3 added sectors, and thirteen increased markedly with twice as many sectors or more addressed as compared to the earlier plans. As of 2014, local authorities in the east of the country are more prepared than those in the west. The eastern plans addressed more sectors and had been updated more recently (shown with ▲) in Map 4.1. With more sectors addressed, they are more prepared and, therefore, less exposed to climate change.



Map 4.1 Added measures included in city and county development plans

4.3. Sectors addressed

In addition to how many measures were included, the types of added measures varied with some sectors being linked more frequently than others as shown in Map 4.2.



Number of local authorities with measures	Climate	Energy Efficiency	Energy Renewable	Flooding	Transport
	30	32	34	30	34
	Coasts	Biodiversity	Water Resources	Green Infrastructure	Carbon Sequestration
	20	6	21	17	19

Map 4.2 Development Plans added measures shown by sectors

The plans included added measures for a wide variety of actions that were grouped into the following sectors: climate change, energy, flooding, transport, coasts, biodiversity, water resources, green infrastructure, and carbon sequestration. As noted in Chapter 3, measures included direct links and actions with relevance to climate change adaptation. These good practice examples are primarily included to illustrate the ways that local authorities are preparing for climate change. In addition, these examples highlight the areas in which effective governance practices are occurring e.g. links with the general public and other private sector actions.

4.3.1. Climate change

Irish local authorities acknowledged climate change in development plans with general references, objectives, and climate action plans. General references link human activity and climate change (Cavan, Monaghan, South Dublin, and Waterford City). Objectives to address climate change focus on strategic framing and general practices. Strategic framing by local authorities focused on recognising climate change as a county challenge (County Limerick) with objectives to reduce greenhouse gas emissions (Clare, County Cork, Galway City, Limerick City, Monaghan, Offaly, Westmeath, Wexford, and Wicklow). In addition, some plans had objectives to reduce their carbon footprint (Clare, County Limerick, Monaghan, and County Waterford). Similarly, some local authorities reference the need for large-scale changes (Clare, Laois and County Limerick). In other cases, general policies and operations were the focus with objectives to incorporate climate change "into policies and development management systems" (Kerry County Council, 2009:68) or into "all levels of its operation and as part of its Business Action Plan and Corporate Plan" (North Tipperary County Council, 2010:144).

Climate action plans are reported in several development plans. Some local authorities have started the process (Limerick City, Sligo and North Tipperary) or identified this as an objective (Carlow, Kilkenny, Westmeath, and Wexford), and others already have a strategy in place (Clare, Dublin City, Laois, County Limerick, Meath, South Dublin, and Waterford City and County). The information in the development plans is not a full accounting of all climate action strategies/plans. Information collected in other parts of this research reveals that some local authorities have published their plans without referencing them in their development plans (see Section 3.1.2.2).

During the time period in which many of the current plans were adopted, there was no requirement to adopt climate action plans. This changed with the *Planning and Development (Amendment) Act 2010*, which requires local authorities to address climate change within their plans. Therefore, the existing plans with references to climate action plans suggest a more integrated, proactive approach. There has been a shift since 2010 with more local authorities referencing climate change in their development plans. In the plans adopted between 2004 and 2010, only 13 had incorporated climate change. In the plans adopted between 2009 and 2014 most local authorities had done so (30 of 34). While more local authorities are incorporating climate change into their development plans, these provisions are still early stage with few specifics.

Alongside increased regulatory requirements, another interpretation is possible. Even within these same set of plans, it may be that some local authorities publicise their actions more than others. The lack of publicised actions does not mean that a local authority has not acted. As discussed in Chapter 5, some local authorities had draft climate change strategies which were not being publicised or put into the policy documents. Therefore, further research was necessary to determine what actions local authorities were taking to address climate change.

Putting these results into a governance context, local authorities are adopting a supportive role and are establishing links with other entities to achieve their goals. Objectives emphasise the supportive role of local authorities using verbs such as facilitate, encourage and support actions. The links with other entities are those with other local authorities and with external entities. The local authorities in the Greater Dublin Area have established links in the form of a Climate Change Project Group that is comprised of the four Dublin Metropolitan local authorities. Outside the Greater Dublin Area, local authorities are establishing links with external entities such as developers (Limerick City), energy agencies (County Limerick, Laois, and County Waterford), and 'key stakeholders' (Wexford). Similarly, the Waterford County Climate Change Forum is an internal working group that identified project ideas that work with the public to address climate change.

4.3.2. Energy Efficiency

Irish local authorities mitigate climate change through energy efficiency and renewable energy. These measures were widespread but limited in scope. Their capacity to advance climate-related measures is limited because they do not control energy production (Bulkeley and Kern, 2006; Mayo County Council, 2014). Energy efficiency measures were in all but two development plans (County Galway and Offaly), and renewable energy measures were adopted by all local authorities.

Energy efficiency measures, those which go beyond meeting minimum requirements, relate to the built environment and require actions by developers, the public and local authorities. Fifty per cent of development plans encourage developers to increase sustainability of buildings in line with national regulations such as the Building Regulations 2011 (DECLG, 2011). Some proactive local authorities have gone further with increased minimum standards and design recommendations. Some local authorities are promoting higher energy ratings than required by the Building Regulations: Carlow encouraging 'A' energy ratings, Cork City and Limerick City both requiring a 'B1' and encouraging higher standards, and South Tipperary requiring 'A3 to B1' for all dwellings and 'A1/B2' for dwellings larger than $250m^2$. Only Clare adopted a higher standard and "will also require that by the end of 2020 all new buildings are nearly Zero-Energy buildings" as per the EU Directive 2010/31/EU (Clare County Council, 2011:159). These increased energy efficiencies address new buildings and do not extend to existing homes. Based on the energy ratings of new homes constructed between 2010 and 2013, some local authorities are achieving greater success than others. For example, these counties (where local authorities had incorporated higher standards into their development plans) had more new homes with higher energy ratings. For example, there were more new homes with energy ratings of 'B1' or greater in County Carlow (69%) and County Tipperary (68%) than in other counties such as County Cavan (33%) and County Westmeath (34%) (Morris-Cadogan, 2014).

Lastly, design recommendations were included by other counties: Fingal and Dún Laoghaire-Rathdown with green roofs to increase energy efficiency, Longford with CO_2 performance and appliance targets, Louth with landscaping to contribute to energy conservation, Monaghan with best-practice environmental management, Roscommon with technology design targets, and South Dublin with passive energy designs.

The public is encouraged by local authorities, through the associated local energy agencies, to increase efficiency. For example, the energy agencies have increased public awareness in both Cork City and Limerick City through a Car Free Day, an

Energy Awareness Week, the Green Flag school initiatives, and *Revitalising Areas by Planning, Investment and Development* programmes.

Local authorities focus on energy efficiency with plans and improvements in council buildings and operations. Energy efficiency plans have been adopted by Kilkenny, Waterford County, and Westmeath. Westmeath's Energy Action Plan "identified in excess of 90 energy efficiency measures across all departments which will potentially save 1,424 MWh annually" (Westmeath County Council, 2014:142). Details were not included in the Kilkenny or Waterford County Development Plans.

According to the development plans, council buildings are more energy efficient than before in 9 local authorities. Cork City "retrofitted 1,600 properties with high efficiency condensing boilers and improved insulation in the last 4 years" through two national schemes: Sustainable Energy Ireland's *Warmer Homes Scheme* and the Government aided *Central Heating Scheme* (Cork City Council, 2009:164). Cork City also plans to prepare an Energy Audit of all their council properties. Similarly, Waterford City reported completed projects (without details), and plans to "improve the energy efficiency of its own 3000 social housing units and [to] source a variety of national and EU funding to achieve this" (Waterford City Council, 2013:171). Also, Mayo upgraded 69 housing units under the Energy Efficiency programme between 2008 and 2012. More generally, local authorities are focusing on the council housing stock (Donegal, Galway City, Kildare, Waterford City), rural housing (Kildare, South Tipperary), edge of centre sites (Wicklow), new major developments (Cork City), tourism facilities (Longford), and materials and operation of new buildings (Limerick County).

Council operations include a mix of stated objectives and completed plans. Five local authorities have objectives to prepare energy plans (Laois, Galway City, Kerry, Roscommon, and South Dublin). Seven local authorities have prepared energy efficiency plans: two through the international Covenant of Mayors' Initiative, two through the national programme with Sustainable Energy Authority of Ireland (SEAI), and three independently.

As part of the Covenant of Mayors' initiative, five local authorities have adopted Sustainable Energy Action Plans (SEAP). Only Dublin City included this information in its Development Plan; the others (Cork County, Kerry, South Dublin, and Waterford County) made no reference to the SEAP or Covenant of Mayors' membership. Dublin

City's SEAP included retrofitting buildings, changing behaviour such as switching off idle appliances, and district heating for new builds (Dublin City Council and Codema, 2010). Kerry's SEAP included more efficient pumping systems, district heating systems, and increased insulation for over 100 houses (Kerry County Council, 2013). Participating in the national SEAI programme, Kilkenny and Meath established and provided training for an energy team, and developed an action plan. Participants in the SEAI programme recognise the need for a coordinated approach. "It is acknowledged that only by ensuring that employees from all areas of the organisation are involved that a local authority can successfully integrate energy efficiency and management into its culture" (Kilkenny County Council, 2014:183).

4.3.3. Renewable Energy

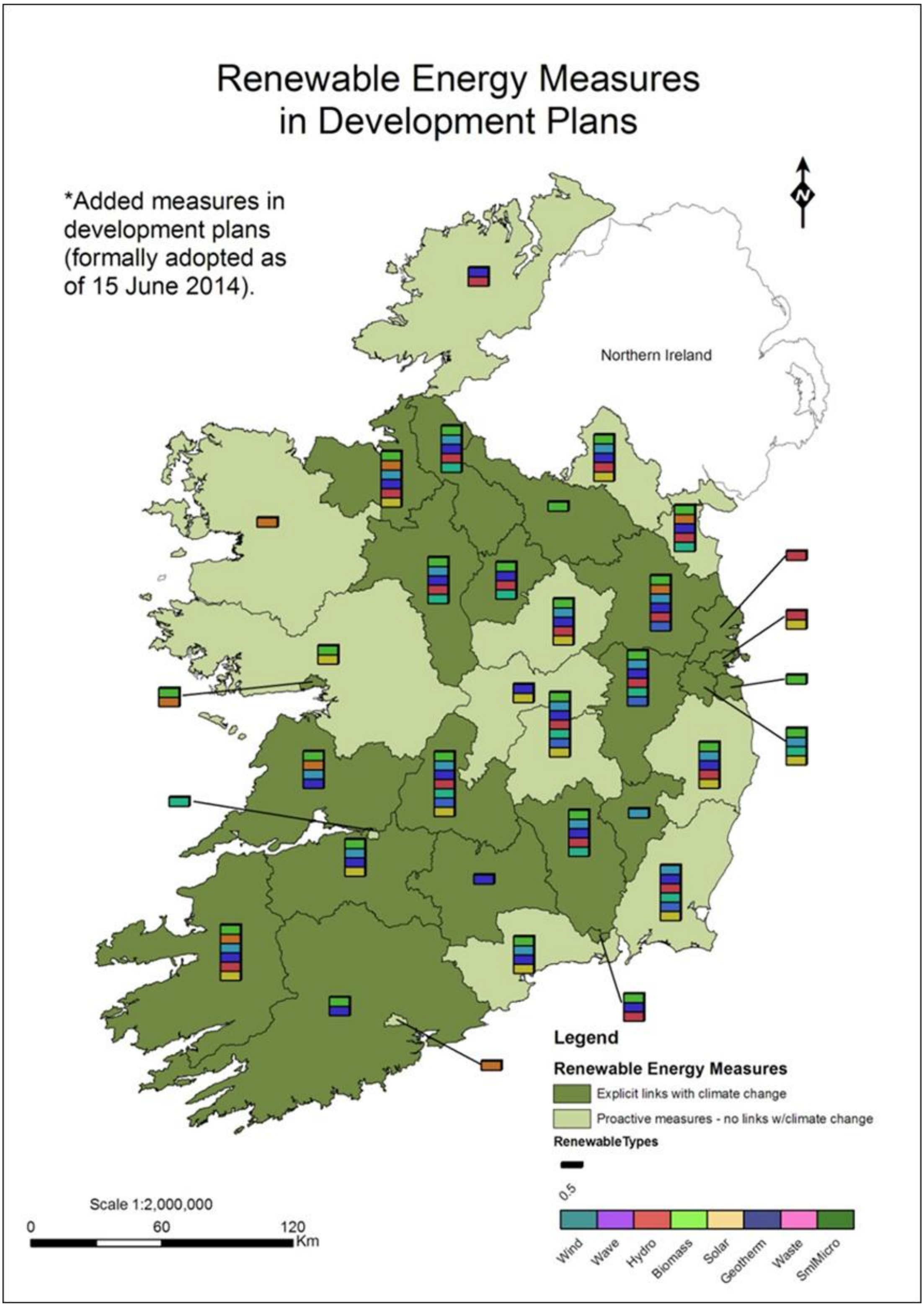
Added measures focused on renewable energy also help reduce carbon emissions. These measures included specific strategies, objectives and demonstration projects. Specific renewable energy strategies have been adopted at regional and local authority levels. According to the county development plans, the Mid-West and South-East regions have adopted bioenergy strategies, and the Border Region is preparing a regional energy strategy. Regarding renewable energy policies, ten local authorities have adopted plans (Carlow, Clare, Fingal, Kilkenny, Laois, Mayo, Offaly, South Tipperary, County Waterford, and Wicklow), and seven other local authorities have objectives to adopt plans (Clare, Kerry, Leitrim, County Limerick, South Dublin, Westmeath, Wexford). Less advanced, Sligo has an objective to prepare a wind energy map.

The objectives included supporting renewable energy and to be front-runners. The objectives to support renewable energy were not always directly linked with climate change and some local authorities listed more types of renewable energy than others. As Map 4.3 shows, twenty-one plans included explicit links (shown in dark green) and thirteen included proactive renewable measures without direct links to climate change (shown in light green). The types of renewable energy are also shown on Map 4.3 with the stacked bars for each local authority. While some counties such as Sligo encouraged most types of energy, others included a much more limited list, e.g. Carlow with only hydro-electricity within its plan. Objectives to be front-runners in renewable energy were driven by agendas for green economy and increased sustainability. Green economy refers to coupling green initiatives with the primary goal of attracting inward investments as in the case of Clare, Donegal, Kerry and County Waterford. Clare seeks to attract inward investment as a self-sufficient, low carbon county. Donegal seeks to become as a centre of excellence for renewables. Kerry is also seeking to attract inward investment from renewable enterprises. County Waterford seeks to develop as a leader of the green economy, and has supported the Energy Self-Supply in Rural Communities Project and associated Waterford Renewable Energy Co-operative.

Front-runner objectives for increased sustainability focused on sustainability rather than increased inward development, e.g. North Tipperary, Westmeath and Wexford. North Tipperary is positioning itself as a "Green Renewable County" through the Cloughjordan eco-village developed as part of the grass-roots Transition Towns movement, and the EU CONCERTO Sustainable Energy in Rural Village Environments programme. Westmeath is participating in the EU Intelligent energy programme, and is preparing a Bio-Energy Plan. Lastly, Wexford's plan seeks to facilitate Sustainable Energy Zones as clusters of public and private entities.

Demonstration projects were listed in a few development plans as already being in place in Ireland. The examples included renewable energy plants, usage examples by local authorities, and demonstration projects. First, renewable energy plants included hydro-electric plants and wind farms. Hydro-electric energy is already being used in Ireland as in the case of several small-scale stations in Sligo, the Ardnacrusha plant in Clare, the Lough Guitane plant in Kerry. Wind farms were also mentioned in development plans: Monaghan with a 5-turbine wind farm and North Tipperary with 35 wind farms operating and 86/90 more permitted.

Second, usage examples by local authorities included Cork City fulfilling 4% of the city's domestic electricity needs from landfill gas, Dún Laoghaire-Rathdown sourcing most of its non-domestic electricity from renewable sources, and Clare powering its Áras Contae an Chláir (council headquarters) by renewable energy. Other local authorities such as Dublin City have objectives to initiate and support demonstration projects. Third, demonstration projects have been set up and are planned around the country. Existing projects include Clare Wood Energy Project, Kinsale Road Amenity Park, Lifetime Lab (Cork City), House of Tomorrow residential scheme in the Glen (Cork City). A proposed project in Cork City is the Kinsale Road Amenity Park which will be created on the site of a closed landfill. The planned project includes a renewable energy facility with timber and green waste processing areas, a combined Heat and Power Plant (CHP) generating 1.8 megawatts of electricity, and demonstration projects for photo-voltaic panels, wind turbine and biomass plots.



Map 4.3 Renewable energy measures by type.

4.3.4. Flooding

Flooding is linked with climate change in most plans and this is increasing over time. While earlier plans adopted before 2010 had few links between flooding and climate change, more plans adopted after 2010 linked the two concerns. These changes are illustrated with five plans: Cavan, County Galway, Leitrim, Offaly, and Roscommon. Energy chapters often listed flooding as an impact of climate change, while sections dealing with surface water and flooding made no mention of climate change (Cavan 2008, County Galway 2009, Leitrim 2009, Offaly 2009, and Roscommon 2009). Later plans adopted after 2010 included climate change considerations within the flooding and surface water sections (Cavan 2014, and draft plans for County Galway 2015, Leitrim 2014, Offaly 2014, and Roscommon 2014). The improved measures in the draft plans are included with the caveat that the plans may change before they are adopted. Therefore, for the purposes of the climate change vulnerability assessment, only adopted plan measures are credited.

Four counties did not address increased flood risk associated with climate change in their current plans: County Galway, Leitrim, County Limerick, and Roscommon. This is likely related to where the individual local authorities are in their development plan cycles with renewals issued each six years. All of these local authorities have issued updated drafts which include climate change references with the exception of County Limerick. In the case of County Limerick, their current plan was adopted in 2010 and the next plan is not due until 2016. County Limerick alludes to climate change but it is much less clear than most plans. Their address is limited to acknowledging rising attention to "changing weather conditions and the possibility of sea level rise and associated storm surge and different tidal patterns" (Limerick County Council, 2010:9-10). This limited mention relates more to coastal concerns than it does to increased flooding risk as applied throughout this section. Therefore, they are not listed as linking flooding with climate change.

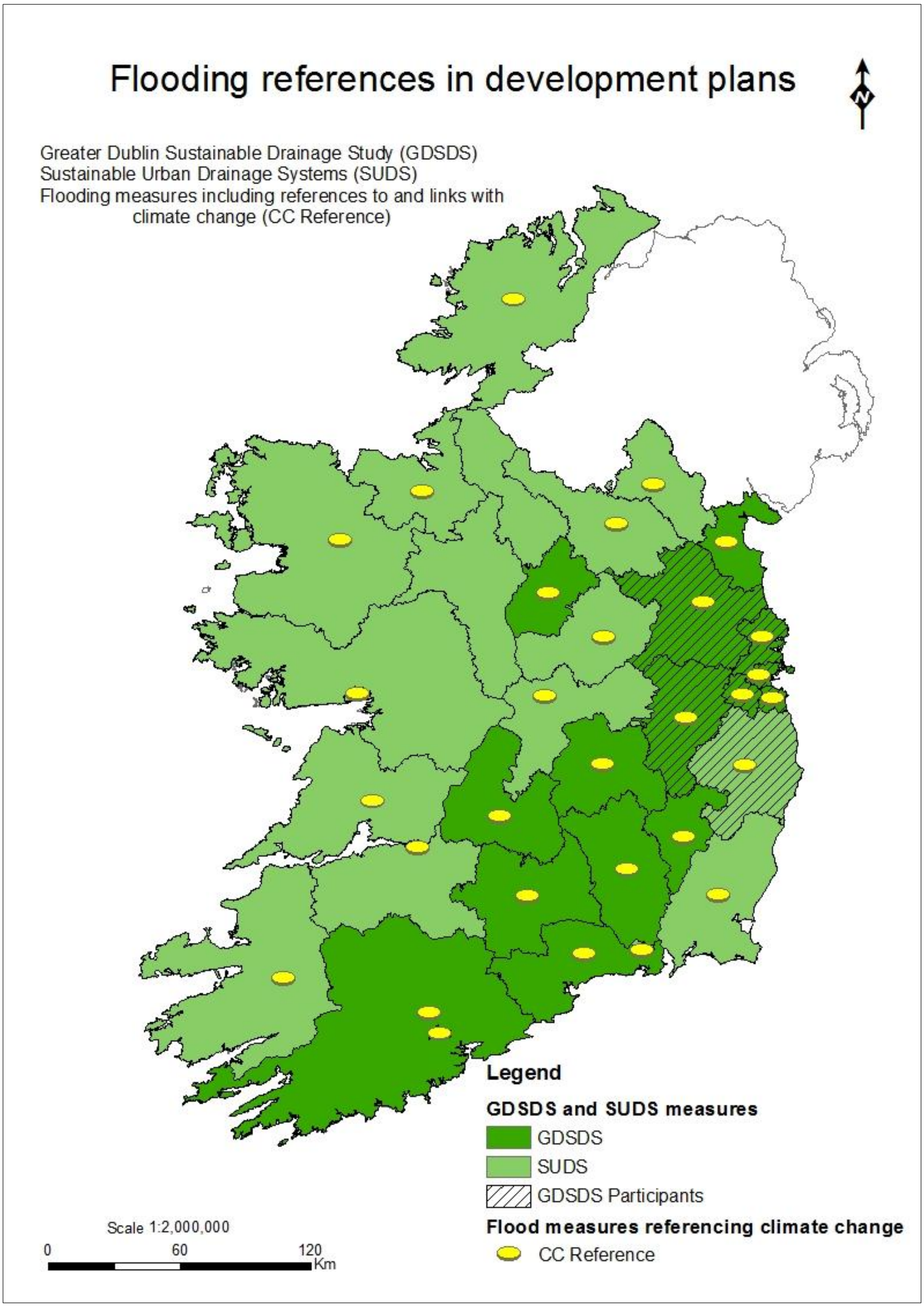
The proactive measures in adopted plans include generalised links, assessments, flood management, and a few unusual references. For the plans that include proactive measures for managing increased flood risk, they acknowledge increasing flood risk with climate change (Carlow, Donegal, Galway City, Kerry, Kildare, Meath, Offaly, Westmeath, and Wicklow), and the importance of managing this risk (Clare, Cork City, Dublin City, Dún Laoghaire-Rathdown, Fingal, Galway City, Limerick City, Meath, and Wexford). A few counties even make specific allowances for increased flooding: Carlow, Kildare and Kilkenny made allowance for climate change using a multiplication factor of 1.2 for 100 year river return periods. Although not adopted yet, draft plans for Offaly and Leitrim also make allowances for the 1 in 100 year flood together with an appropriate allowance for climate change. Less proactive examples included Mayo and Monaghan. Mayo's link been flooding and climate change was more of a generalised objective with few details. Monaghan presented an interesting assessment of climate adaptation for flooding because it discounted the precautionary approach as impractical for built-up areas and included further limitations related to uncertainty. A positive part was that the planning authority was reporting flood risk information directly to the major emergency management committee.

In some instances, the plans went further with assessments and measures. Flood risk assessments of two types were referenced in the development plans: by developers and by local authorities. Even though the assessments were required in light of projected climate change, some plans were unclear about whether the assessments would take account of climate change. First, several plans had policies requiring assessments for new developments. Three of these illustrate useful frameworks to integrate climate change: Longford with recognition of recent changes, Louth with extended requirements, and Cavan with a focus on future challenges. Longford acknowledges recent changes: "It is essential that flooding issues are properly addressed particularly given the swell in developed lands leading to increased run-off and climatic change that has occurred over the last plan period" (Longford County Council, 2009:101). Louth requires developers to assess flood risk for new developments in accordance with *The Planning System and Flood Risk Management Guidelines for Planning Authorities* (DEHLG and OPW, 2009b). More importantly though, Louth goes further and sets out specific recommendations for new buildings including roof structure recommendations, landscaping adjustments, and increased capacity for rainwater guttering and pipework. Lastly, in flood risk areas, Cavan requires flood impact assessments at the planning stage, and Cavan notes "these measures will become increasingly important in future years based on the possible effects of Climate Change" (Cavan County Council, 2014:226).

Second, with reference to assessments by local authorities, several reported Catchment Flood Risk Assessments and Management Studies (CFRAMS). The CFRAM studies are prepared by the Office of Public Works (OPW) jointly with the local authorities. Some CFRAMS were pending at the time of the development plan (Cavan, Monaghan, South Tipperary, and Wexford), and others had been completed (Cork City, Dublin City, Fingal, Meath, and Offaly). The references to some of these plans did not explicitly include references to climate change (Cavan, Cork City, Meath, Monaghan, and South Tipperary). CFRAM studies are prioritised at the discretion of the OPW, which leaves local authorities in a recipient role rather than having the autonomy to address flood risk based on their local knowledge. At the same time, the local authorities and OPW have a close working relationship and the OPW had advanced flood measures in Ireland extensively. Of note, the *Guidelines for Planning Authorities: The Planning System and Flood Risk Management* set the requirements for these assessments (DEHLG and OPW, 2009).

The Greater Dublin Sustainable Drainage Study (GDSDS) warrants special attention. The GDSDS was the most proactive and largest climate change study in terms of participants and uptake by other local authorities. The GDSDS specifically addressed climate change and included an extensive review of climate change science and impacts. Even though only Dublin City and Meath mentioned the GDSDS in their development plans, the GDSDS was a joint effort led by Dublin City Council along with Fingal, Dún Laoghaire-Rathdown, Meath, South Dublin, Kildare and Wicklow. It has also been incorporated into development plans in Carlow, Kilkenny, Louth, South Tipperary and Wicklow (see Map 5.4). These other development plans reference and advocate the GDSDS and further details would be needed to fully assess how well the principles have been incorporated into these councils' practices.

The second type of proactive measures is flood management. The GDSDS also illustrates this point as a good practice example for implementing flood management because it is directly addresses climate change (in a full volume) and is underpinned by Sustainable Urban Drainage Systems (SUDS) principles. A SUDS is a flood management approach to decrease flood risk through increasing onsite infiltration capacity. Some examples are permeable pavements, drainage channels, infiltration systems, water butts, and green roofs (DEHLG and OPW, 2009). As Map 4.4 shows, SUDS have been adopted throughout Ireland with some local authorities also referencing the GDSDS. A few local authorities highlighted specific measures such as green roofs and infrastructure (Cork City, Fingal, Limerick City, and Wexford) and rainwater harvesting (Limerick City, North Tipperary).



Map 4.4 Flood measures in development plans

Overall though, many SUDS references did not include any mention of climate change. Therefore, the measures taken in accordance with SUDS principles may be insufficient to meet the challenge of increased intensity and frequency of storms. The other limitation for both the GDSDS and SUDS measures is that the development plan references are not clear about how extensively these principles have been or will be applied. For example, even when a local authority requires developers to have regard for the GDSDS, the development plans lack details about minimum requirements.

The unusual measures that did not fit neatly into any category were reported by Dublin City, Waterford City and Westmeath. These are included because they highlight possible actions that would help to advance climate measures if other local authorities followed their lead. In addition to the assessments and measures already discussed, Dublin City and Waterford City reported increased flood defences through works with the OPW. Dublin City also reported several projects that incorporate assessments and extend to infrastructure: the 2005 report on Dublin Coastal Flood project, the SAFER project and the Flood Resilient Cities project. These projects are examples of a local authority networking, and they described in more detail in Chapter 7.

Waterford City is also notable because their "climate change strategy influenced their approach to flooding" (Waterford City Council, 2013:29). In this case, climate change considerations, which had already been defined within the climate change strategy, were incorporated into the approach to flooding. Lastly, Westmeath included an "objective to manage areas of proven flood risk to realise their potential multi-functional benefits including their visual, wildlife, climate change and informal recreational benefits" (Westmeath County Council, 2014:112). This was the only local authority which framed the approach to flood risk and climate change in a positive manner, rather than as minimising losses or preventing damages. Progress is more likely when synergies and benefits are explored (Moser and Ekstrom, 2010).

Overall, Irish local authorities compare favourably to UK local authorities regarding flood measures. Most Irish local authorities (88%) linked flooding with climate change whereas 36% of UK local authorities link the two concerns according to Wilson (2006). (This may reflect a temporal change more than a difference between the two countries since the UK policies were adopted between 2000 and the Irish policies were adopted between 2008 and 2014.) Even though most UK local authorities acknowledge flood impacts for the built environment, only 5 of 14 plans reviewed included specific links with climate change (Wilson, 2006). This is interesting because high adaptation sectors in the UK as of 2005 "were those which tend to be most affected by current weather variability and extremes, notably the water supply sector and the flood risk management sector" (Tompkins et al., 2010:630). Tompkins et al. (2010) also noted that there were fewer adaptations for transport, agriculture and forestry, and biodiversity and conservation. While these results are more recent, it still holds promise for Ireland to advance climate change adaptation, especially for flooding.

On a positive note, local authority actions may be more advanced than presented here because local authorities are adhering to the 2009 *Guidelines for Planning Authorities: The Planning System and Flood Risk Management*, which recommends a precautionary approach including climate change impacts. At best, this would mean that the flood assessments adopted this precautionary approach with a long-term view. On a more cautionary note, referencing the above guidelines may only be a token address of future risks without quantified projected changes. The other limitation of these results is that the development plans show intent without confirmed actions to address future flood risks under climate change. Therefore, the extent to which these measures will help with climate adaptation is unclear.

4.3.5. Transportation

The transportation sector presents a challenge in Ireland because of its highly dispersed population, with most people relying on private cars. The potential for proactive measures by local authorities is limited because they serve as facilitators rather than as transportation providers. As a result, even though Offaly and Wicklow recognise and describe the need for sustainable transportation, their vision is not realised because they lack autonomy and capacity in this sector. They encourage actions by others such as developers, employers and private citizens. As part of their support role, they adopt strategies, and provide/encourage ancillary infrastructure.

Local authorities encourage actions by setting requirements for developers, employers, and by supporting local initiatives. Nineteen local authorities require new developments to incorporate public transportation access and bicycle parking facilities.

Fifteen local authorities encourage or require that employers locate close to public transportation, provide cycle infrastructure, and prepare mobility management plans.

Local authorities support local initiatives that involve private citizens in making changes in transport choices. These initiatives include rural transportation programmes, walking buses, special events, private enterprise, and walking and cycling provisions. Twenty-two local authorities listed Rural Transport Initiative Schemes in coordination with the not-for-profit company Pobal that manages programmes on behalf of the Irish Government, and Pobal facilitates local communities in accessing funds from the Irish Government and the EU (Pobal, 2013). More local initiatives, walking school buses and the Green School Initiative Programme were coordinated by local people in many local authorities such as Fingal, Cork City, Kildare, Meath and County Waterford.

Walking and cycling provisions have been included in urban areas to reduce daily traffic and in rural areas to promote recreational uses. Local authorities have encouraged walking/cycling (County Galway, Kerry, South Dublin). Donegal, Kerry, Kilkenny, Laois, Roscommon, County Waterford and Wicklow are examples where the local authorities are promoting both recreational use and a modal shift in transportation use. They support recreational walking/cycling with plans to facilitate car parks for walkers/cyclists, and develop looped walks and green routes; and they support a modal shift by facilitating park and ride facilities and encouraging pedestrian walkways within developments. In addition, Dublin City reduced traffic speeds to 30km on the quays, and Cavan and Laois plan to reduce traffic volumes and speeds in towns.

These provisions may need to be supplemented (North Tipperary and Galway City). North Tipperary noted that "cycling remains a leisure activity within the County. CSO figures in 2006 shows that only 1% of people cycle to work regularly" (North Tipperary County Council, 2010:124). Within its development plan, Galway City noted that the installed cycle and pedestrian facilities have not resulted in more people cycling or walking to work, and they plan to investigate ways to further increase public uptake.

Special annual events include the Cork Cycling Festival, the Laois Walks Festival, and the Sean Kelly Tour in County Waterford. These special events raise the profile of alternative transport modes which may translate to a decrease in private car use for daily trips. Private enterprise examples include an existing car sharing club (Cork City) and proposed car sharing companies (Dublin City and Dún Laoghaire-Rathdown), the Dublin Bikes scheme, Pedal Power Rickshaws (Cork City), the proposed Pilot School Bus Service (South Dublin), and proposed programmes with local bus companies/taxi operators/school bus use during off peak times (North Tipperary).

In addition to supporting local initiatives, local authorities are formalizing their role with local strategies and plans. Local strategies focus on planning and transportation as well as cycling and walking. Many local authorities have completed studies such as The Planning Land Use Transportation Studies (PLUTS)/Public Transport Feasibility Studies (Cork City and County, Dublin City, Galway City, Kilkenny, Limerick City, South Tipperary, Waterford City and County, and Wicklow). Some authorities have gone further and adopted multiple strategies such as Cork City and County with their multiple strategies/plans in place: Cork Area Strategic Plan (including the Heritage Council's 2001 Cork Greenway Study), Public Transport Feasibility Study, Cork Area Transit Study, and a Cork Cycle Strategy. Fifteen other local authorities have objectives to prepare strategies.

Local authorities provide ancillary infrastructure supporting sustainable transport with local projects and larger projects supported by national funding. Twenty local authorities reported local projects such as bus shelters, cycle ways, bicycle parking facilities, advance stop lines at signalised junctions, electric vehicle charging points, and park & ride facilities. Some of these local projects are funded through special development contribution schemes (South Dublin and County Limerick), while others are through national funds from agencies such as Fáilte Ireland (County Limerick). In addition, some local authorities improve links between transport modes (Fingal, Laois, and Leitrim) such as with pedestrian bridges and cycle links (Dublin City, Galway City and County, South Dublin, Tipperary South, and Waterford City). Larger projects have included cooperation between local authorities and national transport agencies to establish quality bus corridors (Dublin City, Meath), cycle ways and walkways (Dublin City and Dún Laoghaire-Rathdown), improved railway provisions (Kildare, Meath, Offaly, and South Dublin), and other projects (Clare, Cork City, and Meath).

The foregoing measures have begun to answer the recognised need to facilitate modal shift to more sustainable transport. Even so, the potential for local authorities to be proactive on transport measures is limited by their role as facilitators (Offaly and Wicklow), and a lack of targets relating to transportation initiatives. Only Dublin has set a target of "25-30% new commutes in the city by bike by 2017" (Dublin City Council, 2011:56). Most local authorities have set objectives to promote sustainable transport initiatives, without targets for specific measures targeted towards climate change.

4.3.6. Coasts

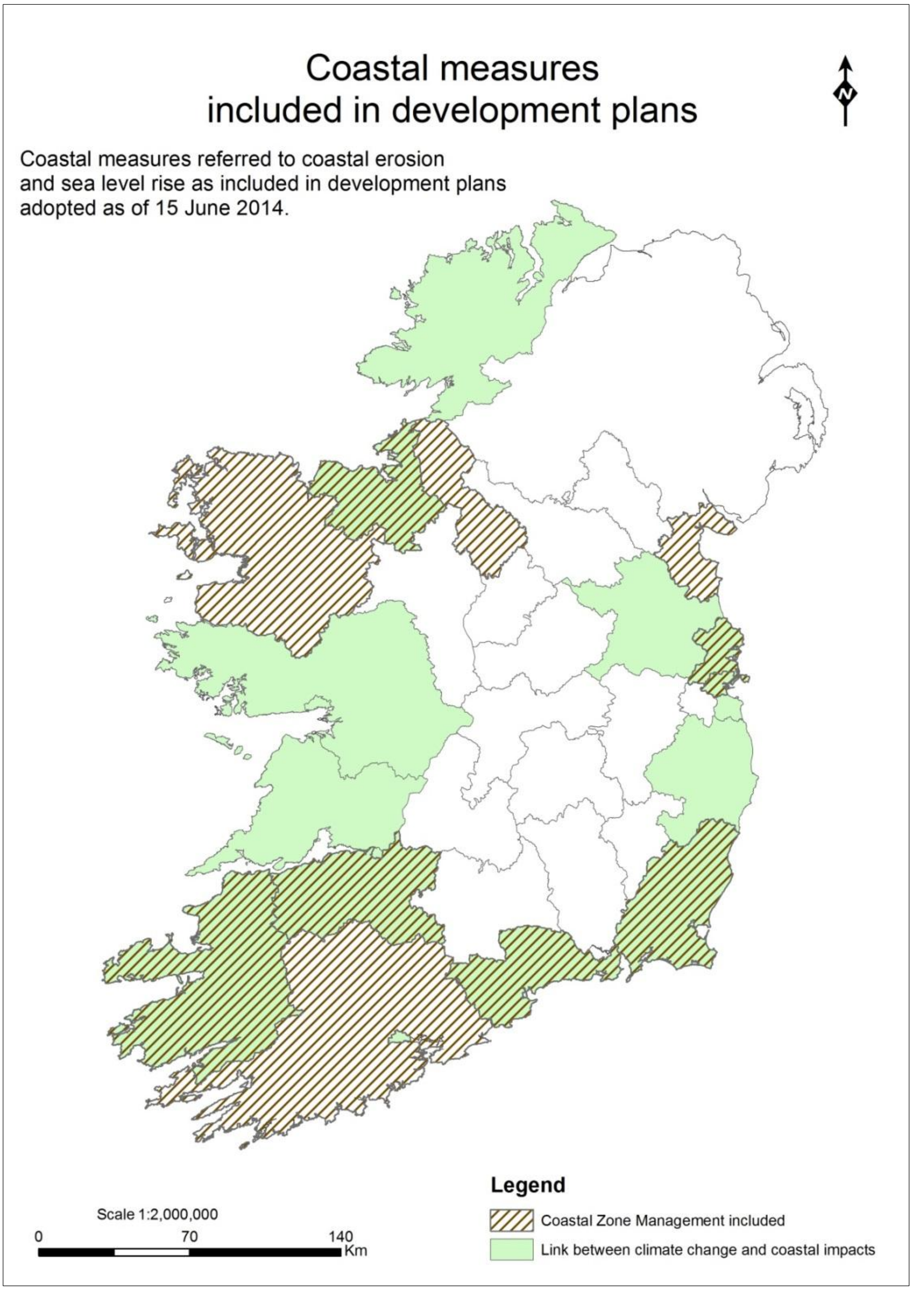
Local authorities linked climate change with the coast, and some adopted an Integrated Coastal Zone Management (ICZM) approach, as shown in green on Map 4.5. Of these, only County Galway and Sligo include measures to adapt. County Galway requires developers to have consideration for sea level rise and climate change and adhere to a 30 metre setback. Similarly, Sligo requires a 100 metre setback and requires that developments have regard for sea level rise.

Many local authorities also set objectives to adopt ICZM into the policies and practices, as shown by shading on Map 4.5. A few local authorities have not acknowledged the link but still espouse the ICZM approach: County Cork, Leitrim, Louth, and Mayo. County Cork has participated in international ICZM projects with objectives to address climate change. Even so, County Cork's current development plan does not link climate change and coasts beyond this. The only reference in the 2009 development plan is that Lough Hyne near Skibbereen has transitioned from freshwater to marine because of sea level rise. Its draft 2013 development plan goes further and acknowledges climate change as one of the "key issues facing the coastal zone of Cork": "Adaptation and mitigation of the impacts of climate change in particular sea level rises, flooding and coastal erosion" (Cork County Council, 2013:71)[6]. Therefore, some local authorities are moving forward on climate change and coastal impacts.

Leitrim, Louth and Mayo are similar to County Cork in that they have a stated objective to address coastal zone management but without addressing climate-related impacts for coastal areas. Regarding the 5 kilometres of coastline, Leitrim will work with Sligo and Donegal in any plans to protect Donegal Bay. Louth acknowledges the national requirement for an ICZM plan and refers to an ICZM plan for the north side of Carlingford Lough. In addition, Louth has a policy "to protect areas at risk from coastal erosion and flooding, subject to available resources" (Louth County Council, 2009:120). Conversely, Mayo does not address climate-related coastal impacts within

[6] Cork County Development Plan was subjected to Ministerial Direction on 22nd December 2014 and the draft plan came into effect on 15th January 2015 (Cork County Council, 2014).

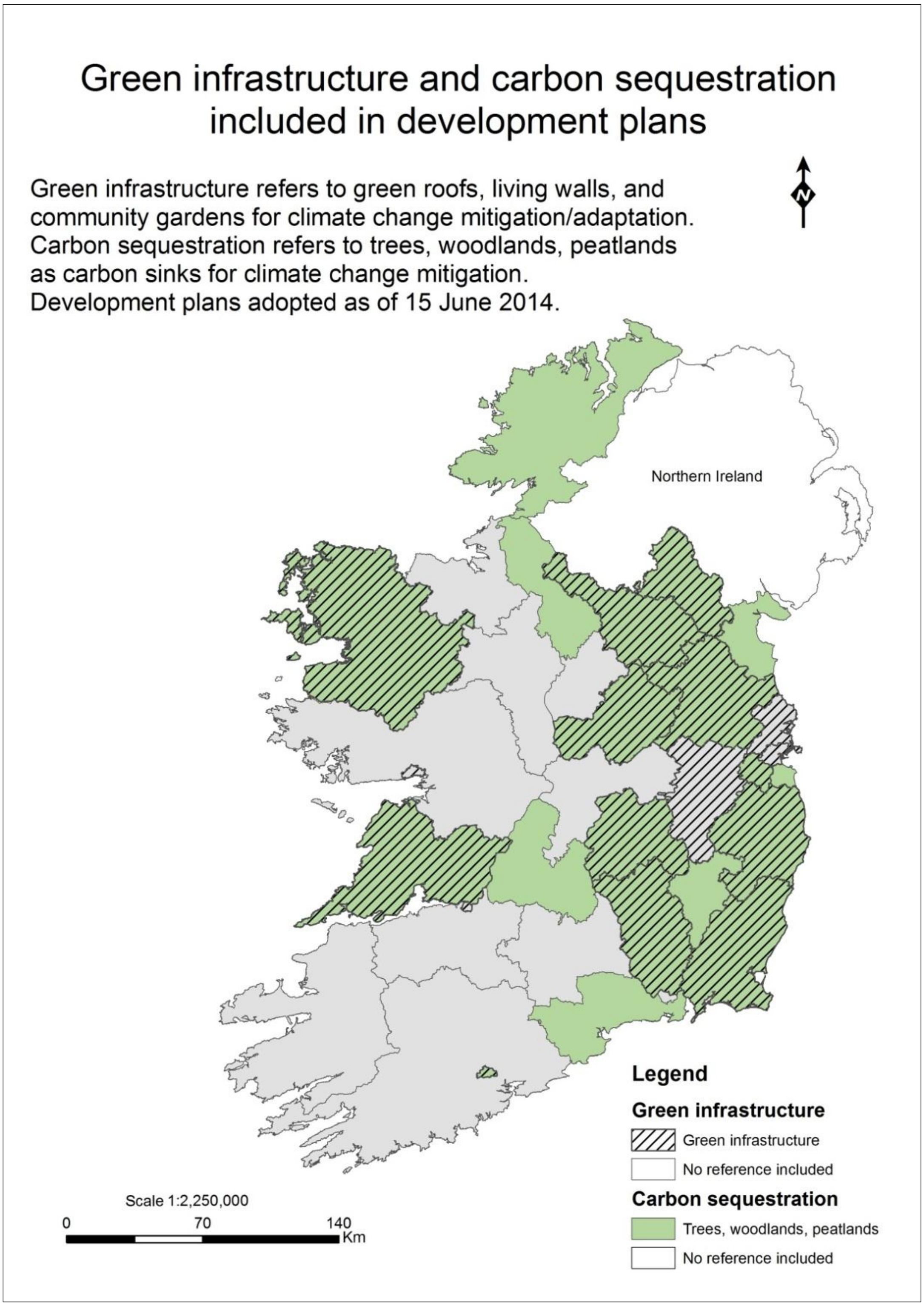
their current development plan. The previous 2008 CDP required developers to have consideration for sea level rise and climate change and adhere to a 30 metre setback. The current 2014 CDP has a more generalised policy to adopt the ICZM approach and to support the NCCS by supporting coastal zone management.



Map 4.5 Coastal measures

4.3.7. Carbon sequestration

Carbon sequestration and green infrastructure were acknowledged mostly by local authorities in the north east and south east of the country as shown in Map 4.6.



Map 4.6 Carbon sequestration and green infrastructure measures

Carbon sequestration references, shown in light green on the map, were mainly acknowledging the role of trees, woodlands and hedgerows to assist in carbon storage. There were only 2 local authorities who reported completed progress: Cork City planted 3,000 trees and South Dublin planted 192,000 trees and shrubs.

4.3.8. Green infrastructure

Similarly, green infrastructure references, shown as shaded areas on Map 4.6, were mainly to set objectives to prepare green infrastructure strategies and to acknowledge the potential for climate mitigation and adaptation. Green infrastructure includes green roofs, living walls, and community gardens. Again 2 local authorities reported completed projects: Dublin City with the Father Collins Park as Ireland's first wholly sustainable park, and South Dublin with green roofs installed in three locations at Corkagh and Saggart park depots and the Green Machine building in Lucan.

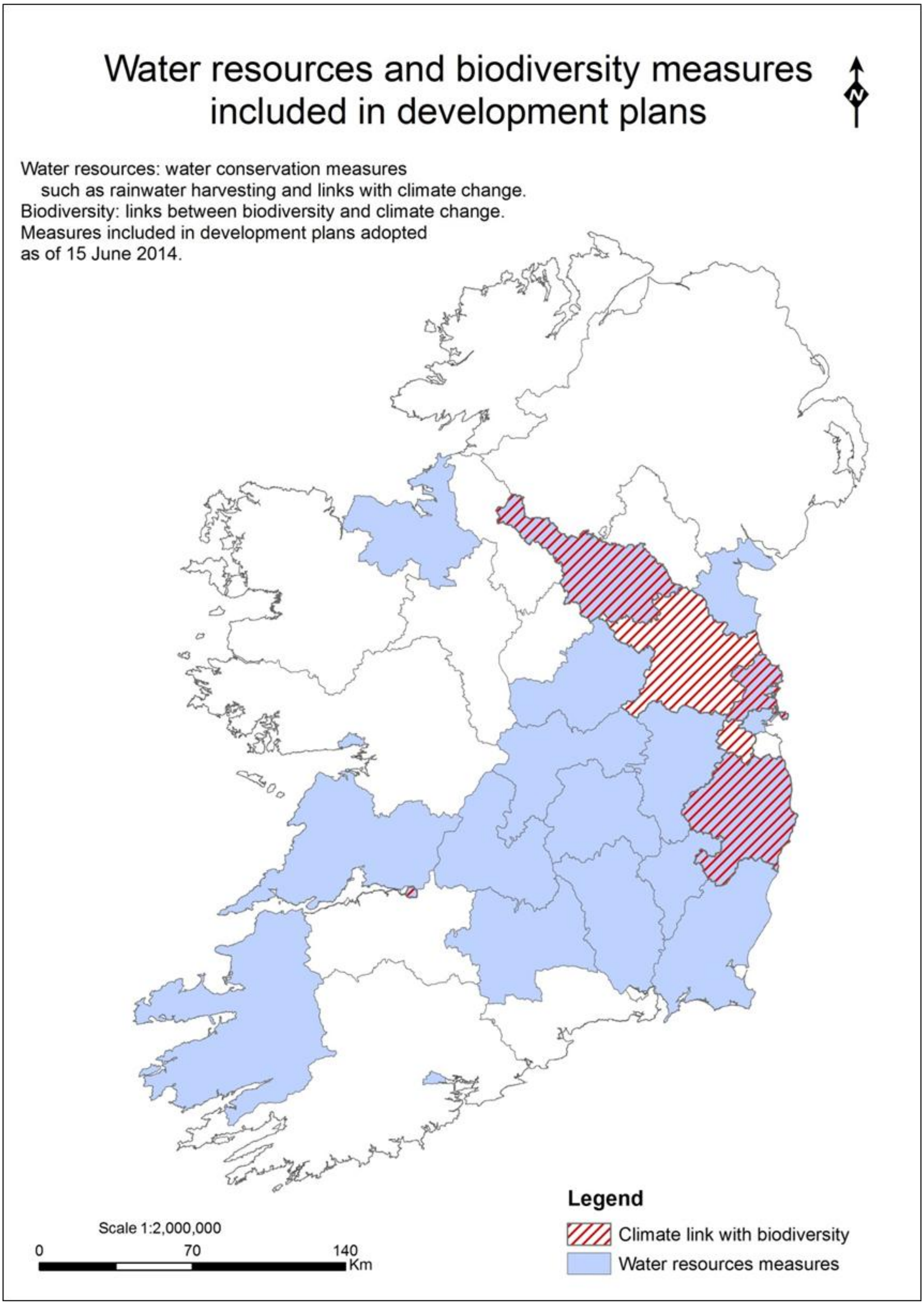
4.3.9. Water resources

Most local authorities (62%) linked climate change with water resources as shown in blue on Map 4.7. The water resource measures included mainly water conservation, and some links with water quality. Most water conservation measures were to promote and encourage rainwater harvesting in new developments. While some local authorities, e.g. Fingal, link rainwater harvesting with flood management, most local authorities included this with a focus on water conservation. Dublin City advocates rainwater harvesting for both flood protection and water conservation as shown on their website (Dublin City Council, n.d.), in the *City Development Plan* (Dublin City Council, 2011:70), and in the *Greater Dublin Strategic Drainage Study – Environmental Management Policy Sheet* as shown on the UK Sustainable Drainage Guidance & Tools website (HR Wallingford Ltd., n.d.).

Less specifically, a few local authorities, such as Cavan and Offaly, have more generic objectives to promote water conservation. Only Fingal, Limerick City, and South Dublin plans linked climate change with water quality.

4.3.10. Biodiversity

Only five local authorities (Cavan, Fingal, Meath, South Dublin, and Wicklow) linked climate change with biodiversity as shown in the shaded areas on Map 4.7. This represents as serious omission suggests a lack of awareness for the implications of climate change as it will affect biodiversity.



Map 4.7 Water resources measures

4.4. Types of measures

In addition to the number of measures each council included, the types of measures varied as well. Local authorities have been preparing for climate change through linking climate change with other sectors, setting objectives, taking specific actions, facilitating actions by others, and requiring actions by others. The types included links, objectives, plans, facilitating and requiring actions by others.

These actions are summarised in Table 4.1 below showing type types of actions listed separately for each sector. An asterisk marks the cases where very few local authorities had taken actions, such as links with biodiversity and plans for carbon sequestration. The links between climate change and specific sectors included recognising the effects of climate change on the sectors such as climate change negatively affecting biodiversity through changed habitats or climate change being a driving force for increased energy efficiency. Objectives were set by local authorities to incorporate climate change considerations into flood risk management and other sectors. Plans included by local authorities were specific actions taken or policies adopted such as Cork City Council having planted 3,000 trees annually over the last 20 years to reduce carbon dioxide and improve the built environment. Facilitating actions by local authorities support public actions without mandated action by the public, e.g. facilitating mixed use developments as a means of reducing greenhouse gas emissions. Lastly, requiring actions by local authorities go a step further and mandate specific actions by the public such as requiring developers to provide cycle parking as part of new developments.

Table 4.1 Types of actions included in development plans

Sectors	Types of Actions				
	Links	Objectives	Plans	Facilitating	Requiring
Climate change	√	√	√	√	
Energy efficiency		√	√	√	√
Renewable energy	√		√	√	
Flooding	√	√	√		√
Transport	√	√	√	√	√
Coasts	√	√			√
Carbon sequestration	√		√*		
Green infrastructure	√	√	√*		
Biodiversity	√*				
Water resources	√	√		√	
Totals	9	7	7	5	4

As Table 4.1 shows, local authorities were most likely to recognise links and set objectives to address climate change. These actions are early stage forms of building capacity. When considering the number of sectors addressed, as shown by the totals in Table 4.1, fewer specific plans had been adopted by local authorities. These actions included adopting specific policies, setting specific plans, and demonstration projects.

The fewest actions were reported for the two remaining types – facilitating and requiring actions by the public and businesses. Given that an integrated approach is needed, and that governments have moved from unitary actors towards a more facilitatory role, this suggests that there is a significant gap regarding climate change. Further, this reflects shortfalls in effective governance which would increase effective climate adaptation. According to their development plans, local authorities have not broadened their focus on climate change beyond their internal plans and policies.

4.5. Discussion added measures in development plans

Overall, Irish local authorities are ill-prepared for climate change, and climate change governance is very weak in Ireland. Local authorities are ill-prepared for climate because current measures are more aspirational than realised. Local authorities are in the early stages of adapting to climate change. This is evidenced by more objectives than concrete measures in development plans. Except for flooding and renewable energy, few local authorities reported completed actions. Further, the development plans reported no baseline assessments, quantified targets, or annual reporting commitments.

Climate change governance is very weak in Ireland as shown by integration shortfalls within the local level and between the local and national levels. Integration shortfalls within the local levels were evidenced by a marked lack of links in most sectors between local authority actions/responsibilities and the general public and businesses. This was especially true for areas where there are limited requirements for local authorities to address climate change such as carbon sequestration, green infrastructure, and biodiversity.

Integration shortfalls between local and national levels were evidenced by 1) lack of a standardised approach, and 2) the fact that local policies do not reflect national objectives regarding climate change. First, the lack of a standardised approach is reflected in the sectors addressed and the types of measures. While some local authorities adopted measures for most sectors, many still had not linked climate change with some or many of the sectors. This was especially true for emerging measures such as carbon sequestration and green infrastructure. In addition, the same applies for biodiversity which has been less well addressed in development plans more generally even before climate change was being considered.

Second, national objectives regarding climate change are not reflected in local policies. As noted in Chapter 1, even allowing for the limitations in national policies, the national government has identified climate change as a priority and recognised the significant role of local authorities in meeting this priority (DEHLG, 2007a). This identified role has resulted in early stage measures for direct emission reductions such as objectives for energy efficiency and renewable energy plans. At the same time, this identified role has not resulted in the actions of "raising awareness and stimulating action in local communities, and indirectly through the exercise of their housing, planning and other statutory functions" (DEHLG, 2007b:36).

Local climate measures and governance may improve over time given the recent expanded focus on adaptation in the 2012 NCCAF and the proposed 2015 Climate Action Bill. Early indications of this potential are evidenced by the increase in mainstreamed measures in development plans between 2004 and 2014. This was especially true regarding links and objectives specifically focusing on climate change.

The foregoing evaluation only considers the published commitments and objectives within local development plans. Based on this part of the research, more measures are likely. This was the case when considering climate measures where only Dún Laoghaire–Rathdown referenced regional cooperation in the Dublin region even though Dublin City, Fingal and South Dublin were clearly involved as well. Therefore, the information collected and reported herein increases available knowledge about climate change mainstreaming by Irish local authorities; a fuller understanding of local authority actions and potential requires consideration of the internal practices as well as the driving forces.

Chapter 5. Climate Change Vulnerability Assessment

5.1. Introduction

This chapter presents results from the climate change vulnerability assessment to provide information as to how climate change will affect Irish local authorities. Because the timeframe for changes in physical exposures ranges over decades, this assessment represents a snapshot view relative to longer term considerations of climate change. Conversely, because the timeframe for policies and related adaptive capacity is much shorter, it was possible to observe changes between 2009 and 2014. The study's results have not previously been available at the county level in a national context, and are needed by local authorities as first responders and planning authorities in their jurisdictions. The assessment examines possibilities for local government adaptation. It does not extend to the vulnerability of individuals within the local authority area.

The results in this chapter describe how different local authorities will be affected by climate change and considers their potential to address these effects. The sectors relevant to climate change, as discussed in Chapter 1, include flooding, landslides, energy use, biodiversity, water supply, and coasts. This assessment examines how exposures and impacts vary for these sectors individually and in combination. In addition to the physical exposures, local authorities have different levels of adaptive capacity to address climate change. Some have high levels, and others have more limited adaptive capacity. Therefore, this chapter presents an analysis of climate change vulnerability which includes physical climate exposures by sector, overall climate change exposure, and adaptive capacity. These results also consider vulnerability, where the greatest number of people will be affected.

5.2. First research strand - climate change vulnerability assessment

This baseline climate change vulnerability assessment of Irish local authorities includes physical exposures, impacts and adaptive capacity. The assessment shows that some local authorities are more exposed to climate change than others. It is likely that the local authorities with low exposure and impacts will require fewer adaptation measures. Of course, even local authorities with low exposures and impacts are likely to experience some challenges associated with climate change. For example, in counties with a low vulnerability ranking where there are few floods in a given area, even a small increase in the number or intensity of floods can threaten people, their homes, and public buildings since they may be unprepared.

The results presented here are based on the Füssel and Klein (2006) framework as adopted by the EEA (2008), which was discussed in Chapters 2 and 3. This framework characterises vulnerability as the combination of physical factors and adaptive capacity factors. As noted by Aall and Norland (2005), it is where the two exposures/impacts are greatest that the greatest vulnerability is present.

Specific sectoral and overall climate change exposures are relevant for each local authority, with some sectors having greater exposure in a given local authority as well as their overall climate change exposure. As summarised in Table 3.1 in the Methodology Chapter, the sectors are examined in turn to explore the different factors involved. For example, flooding exposure is evaluated by recorded flood events and projected increases in winter rainfall. Some counties have high exposure for one or two factors/indicators which may not show-up at an aggregated sectoral level, even within a county. For example, a county with low levels of recorded flood events, and high levels of winter rainfall increases, will be affected by climate change even though its overall flood sector exposure is moderate. Therefore, the individual indicators are discussed as well as the overall sectoral exposure. The indicator maps are included in Appendix C together with data tables in Appendix B. These data tables record the baseline data and provide information for comparative studies.

Both the climate-related exposures and impacts are important when adapting to climate change. Exposures illustrate the climate-related events and conditions that threaten our landscape, biodiversity, and people. In addition to the exposures, consideration must be given to the differential impacts that are greater in densely populated areas due to effects such as the disruption of economic activities and major transport links. The impacts in rural areas are also considered, such as road closures due to flooding and landslides. These impacts are the outcome of the sensitivity analysis which weighted the exposures by population density. These results are presented with exposures and impacts in tandem. The implications for decisions regarding equity and resource allocation are considered in the Conclusions chapter. The results from the climate change vulnerability assessment are presented in three parts: (i) physical exposures and impacts, (ii) adaptive capacity exposure and impacts, and (iii) climate vulnerability.

5.2.1. Physical exposures and impacts

Six sectors were examined for exposure and for impact (exposure weighted by population density): flooding, landslides, water supply, biodiversity, coastal erosion, and sea level rise. Transfer of water supply responsibility from local authorities to the semi-state company Irish Water began in January 2014 and will be completed by 2019 (Irish Water, n.d.). Therefore, it is acknowledged that this sector has more limited future relevance to local authority exposure to climate change. Overall these sectors were selected based on the local authority remits and excluded other areas such as agriculture.

The assessment was based on climate change projections, recorded events, and land attributes. Appendix A includes national maps for each indicator, Appendix B includes data tables for each sector, Appendix C includes national maps for each sector, and Appendix D summary tables showing detailed national results for the following:

- Relative Ranking Category values for indicators and sectors (Table D.2),
- Averaged exposure values for each sector, listed by council (Table D.3),
- Averaged impact values for each sector, listed by council (Table D.4),
- Summary table of greatest exposures and impacts (Table D.5, and
- Comparison of exposure and impact for each sector by council (Table D.6).

The discussion of each sector follows, including graphs for the individual indicators and maps for the sectoral exposure and impact. The graphs for the indicators show the different ranked categories of exposures, with very low exposure shown in the lightest shade through to very high exposure in the darkest shade. This graphical presentation shows the values for each county as well as the range of values included for each ranked category. The maps for sectoral exposures and impacts represent the combined ranking for each county based on the averaged indicator ranks.

5.2.1.1. Flooding

Flooding exposure was evaluated using the average class ranking for two indicators: reported flood events and winter rainfall increase. As noted in Chapters 3 and 4, the flood exposure represented here is an initial scoping that gives an indication of the trends rather than a detailed assessment intended for planning purposes.

Recorded flood events were much greater for some counties than others: counties reported between 52 and 515 events. While some areas are more prone to flooding than others, other factors may also shape these patterns. For example, some local authorities may have better reporting practices driven by high density populations, the presence of critical infrastructure, or areas of high amenity. Further, the flood records for some counties have been updated as recently as 2014 e.g. Dublin, while others are less current such as Laois which was dated most recently in 2009 (see Map A.4 in Appendix A for a full listing).

As Figure 5.1 shows, the most reported events (very high exposure as shown in darkest blue) were in Galway (515), Cork (503), and Dublin (399). Planning for flood risks present different challenges depending on the particulars of the areas flooded. Of note, Galway included 144 floods in turloughs which are natural areas that flood seasonally (Sheehy Skeffington et al., 2006); the challenges for Galway County Council will likely relate to roads, rural properties and biodiversity. The remaining other two very high exposure counties include the high density urban areas of Cork City and the Greater Dublin Area. These local authorities will need to address the effects on highly urbanised areas. Flood exposure is not only a concern for those counties with high flood exposure. Even counties with relatively few reported events (very low exposure as shown in the lightest shade) will still need to address flood exposure which may increase with climate change.

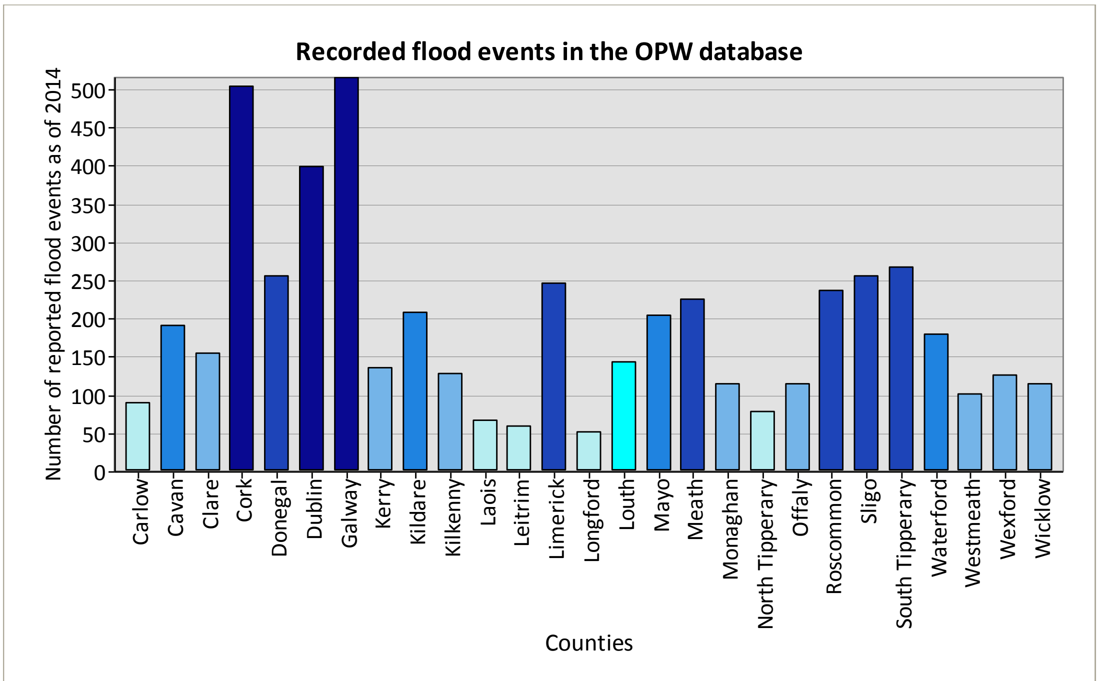


Figure 5.1 Flood event records for recurring and non-recurring floods (OPW, 2014)

Based on the dataset used within this research, winter rainfall is projected to increase in counties between 10.2% and 19.5% (Met Éireann dataset). These projected increases are based on the climate projections which have inherent uncertainty as discussed in Chapters 3 and 4. The available conclusions regarding increased winter precipitations are limited by those uncertainties. Even so, these uncertainties are not an adequate justification for delaying adaptation.

Based on the available information, Figure 5.2 shows the greatest increases (very high exposure) are projected for Carlow (19.4%), Waterford (19.0%), Wicklow (18.6%), and Kilkenny (18.5%). The lowest increases (very low exposure) are projected for Limerick (11.6%) and Donegal (10.2%). All of these increases focus on the percentage increase comparing the baseline period (1961-1990) with mid-century (2031-2060) projection. In some cases local authorities are already experiencing high winter precipitation levels, and these local authorities are likely to face continued challenges related to future flooding.

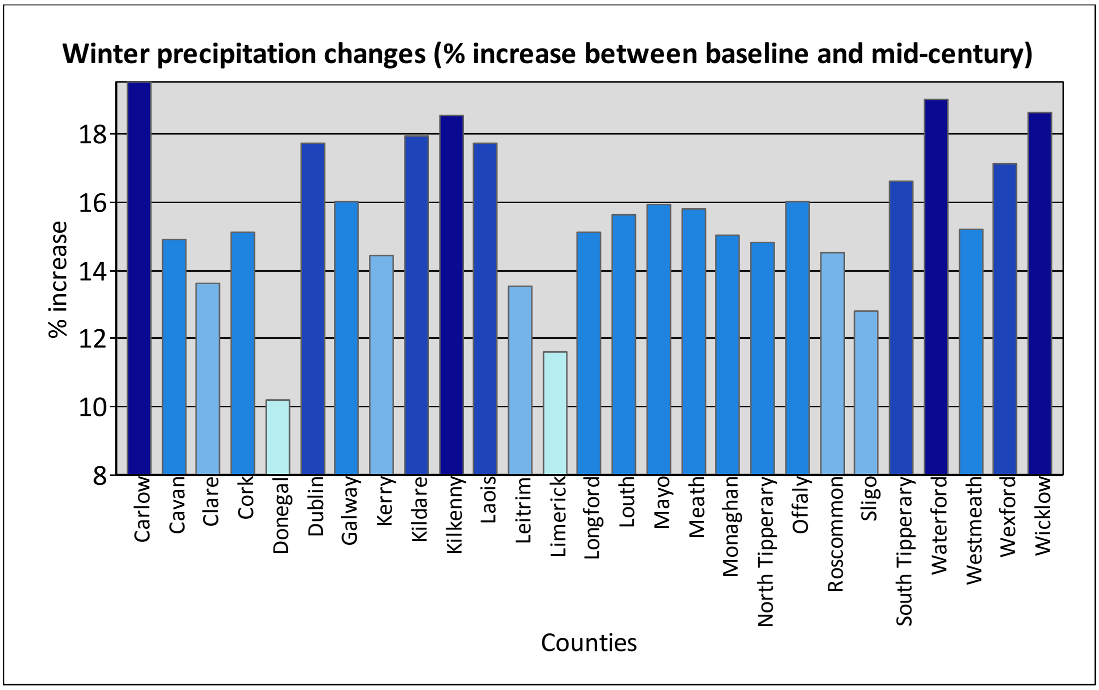


Figure 5.2 Winter precipitation increases by mid-century: averaged values by county

Bringing together the exposure of recorded flood events and projected precipitation increases gives an indication of each county's future flood exposure. As Figure 5.3 shows, the historical exposure (shown in red) may be very different than the projected increases (shown in blue) for a given county. For example, Carlow has reported relatively few floods, but precipitation increases are projected to be high. Conversely, Limerick has reported many floods, but precipitation increases are projected to be very low. Overall, the combined factors (shown in yellow) represent an average of the two relative ranks (reported flood events and projected increases).

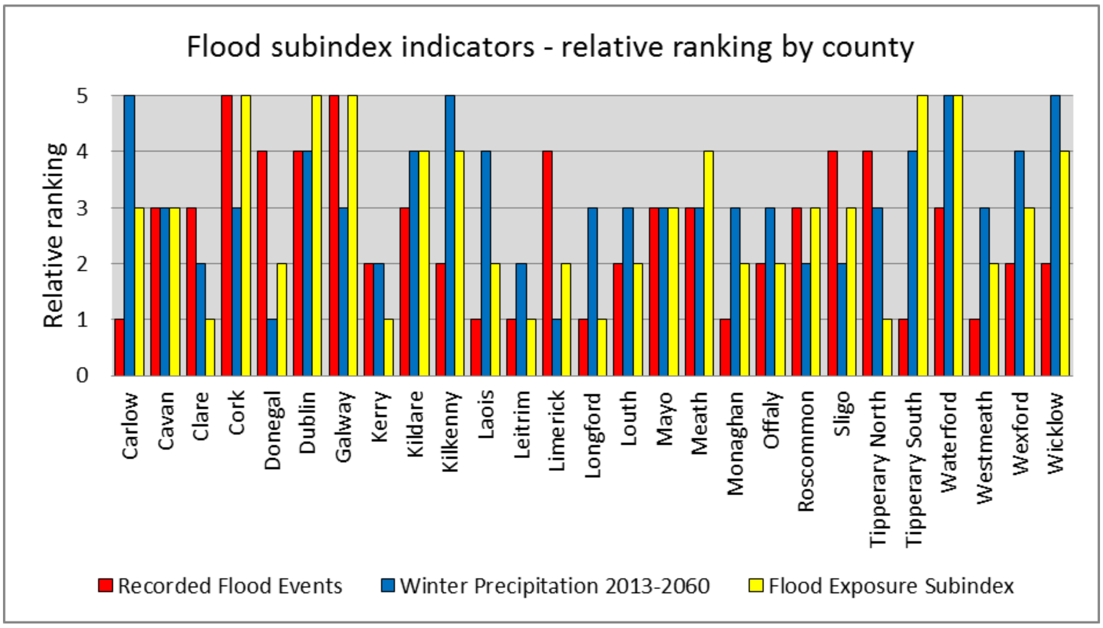
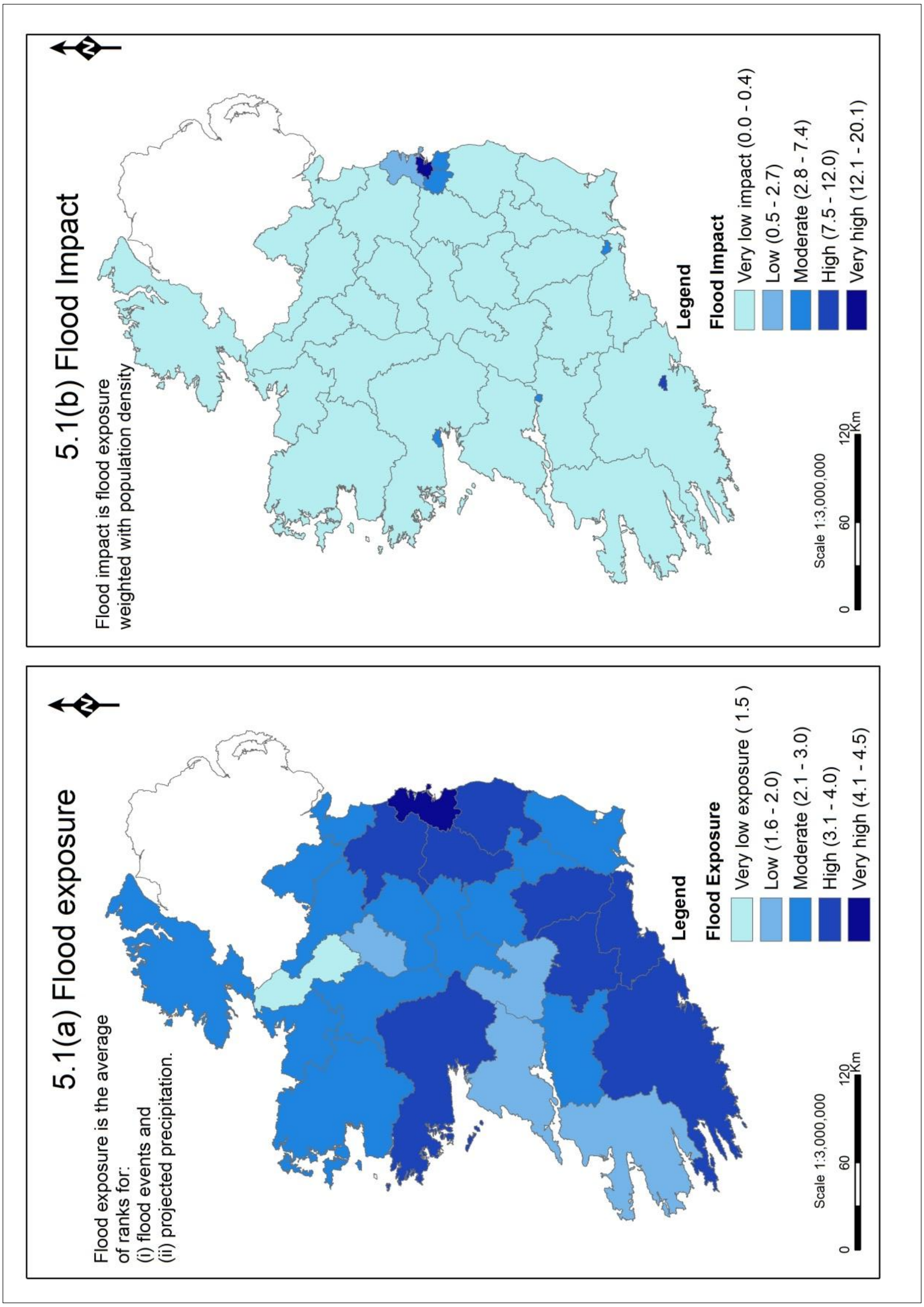


Figure 5.3 Flood exposure: relative ranking by county for indicators and sub-index

Map 5.1 shows both the exposure in Map 5.1(a) on the left and the impact in Map 5.1(b) on the right. As Map 5.1(a) shows, the projected flood exposure is greatest in Dublin, followed closely by high exposure in the western county of Galway; eastern counties of Meath, Kildare and Wicklow; and southern counties of Cork, Kilkenny, South Tipperary, and Waterford. For impact of this exposure, cities and counties were separated, and the number of people for each was considered as shown in Map 5.1(b) on the right. This more detailed approach provides information about where the greatest number of people is likely to be impacted. Again, the greatest impact was in Dublin City, and high impact was also in Cork City. Local authorities need to consider both these metrics (exposure and impact) to address areas that will experience the most floods, and where the greatest number of people will be impacted.



Map 5.1a and 5.1b Flood exposure and impact

5.2.1.2. Landslides

Landslide exposure varied throughout Ireland both in recorded landslide events and in land attributes that have been linked with landslides. There have generally been few recorded landslides in Ireland and the records have been expanded through additional studies as described in Chapter 3. As Figure 5.4 shows, the greatest number of recorded landslides (very high exposure) was in Wicklow with high exposure recorded in Cavan, Leitrim, and Sligo. Also of note, there were 41 landslides recorded in County Dublin, such as on the M50 Motorway, in Strawberry Beds, and Killiney.

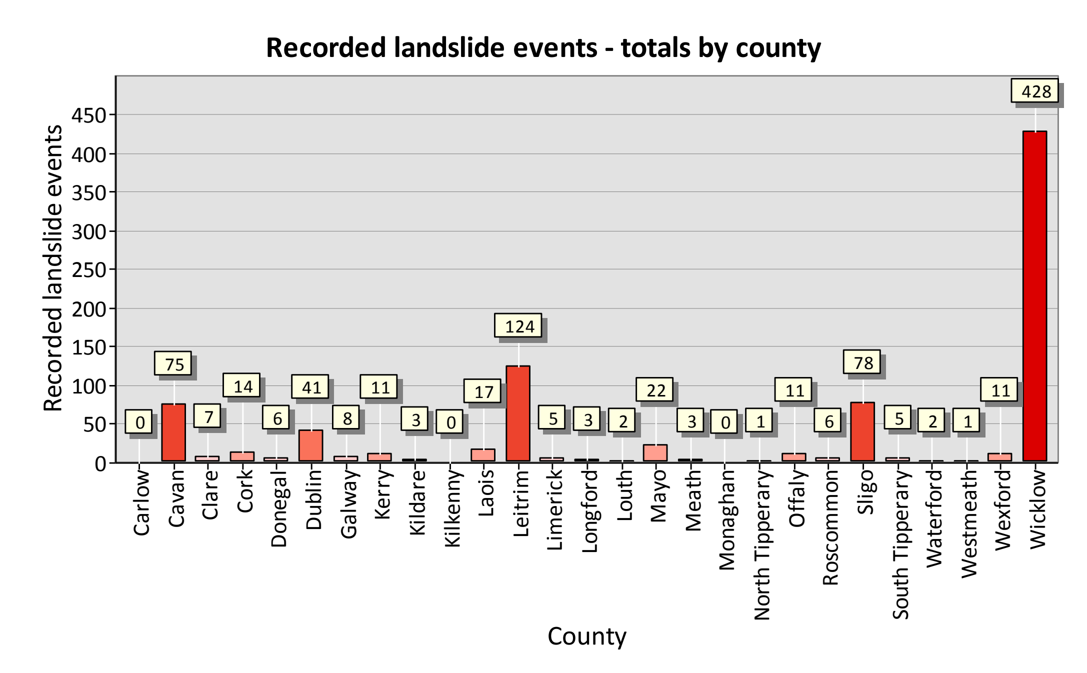


Figure 5.4 Total recorded landslide events by county

As noted in Chapter 3, the available information about recorded landslides in Ireland is incomplete. For example, local studies in East Leinster expanded the known number of landslides appreciably in Wicklow and County Dublin. Wicklow's total recorded landslide numbers increased from 17 to 428, and County Dublin's recorded landslide numbers increased from 6 to 41. Further local studies in Kerry and Mayo, as being carried out by Trinity College Dublin under the GSI's direction, are anticipated to expand the known number of landslides in these areas. Therefore, this information shortfall, as well as other factors for landslides, should be considered when planning.

The land attributes related to high landslide risk were determined as high slope areas and peatland areas (Bone, 2012). Kerry has very high exposure for both factors as shown in Figures 5.5 and 5.6. Kerry and Mayo had few recorded landslides in a national context; however, a fuller picture may be revealed with the pending GSI research. Wicklow's mountainous terrain and peatland areas correspond with a very high number of recorded landslide events based on the database as shown in Figure 5.4.

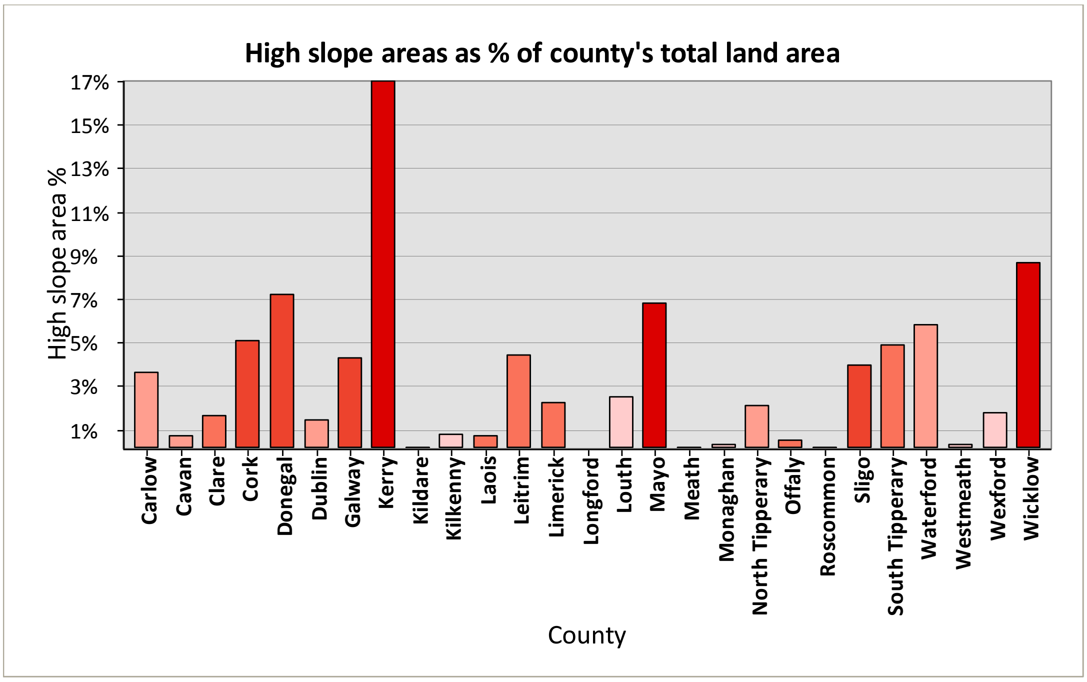


Figure 5.5 High slope areas by County (EPA DEM)

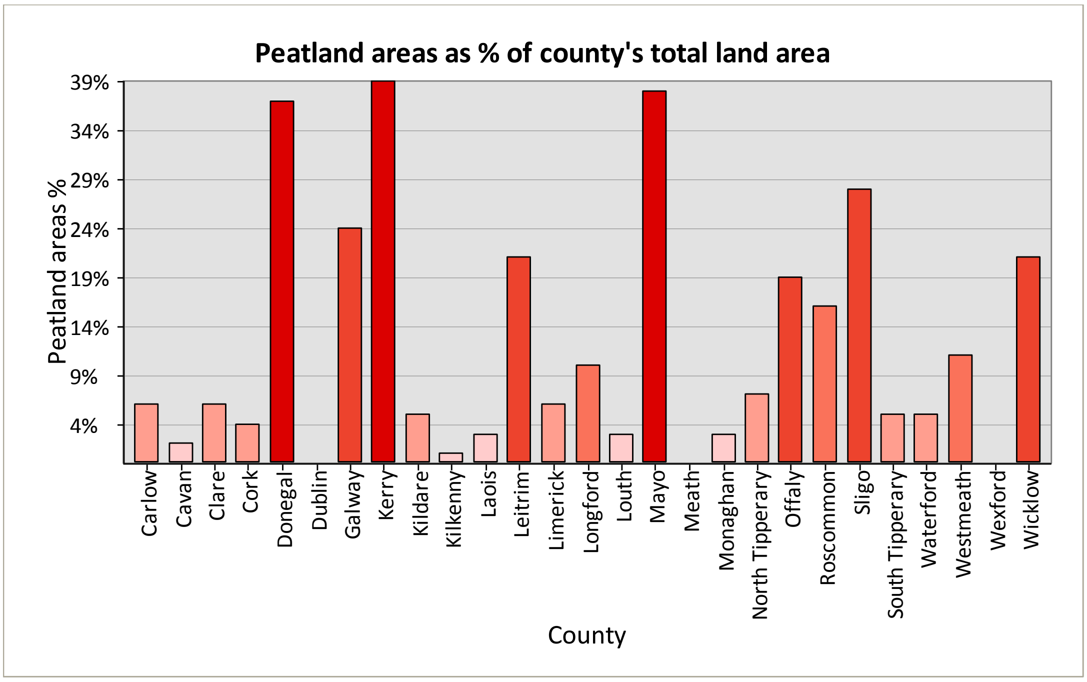


Figure 5.6 Peatland areas by County (CORINE 2006)

Bringing together the foregoing results, Wicklow and Kerry have very high exposure to landslides as shown in Figure 5.7 and Map 5.2(a). While Mayo and other north-western counties had high exposure related to their land characteristics, their lower number of recorded landslides result in a “high”, rather than “very high”, overall landslide exposure in a national context.

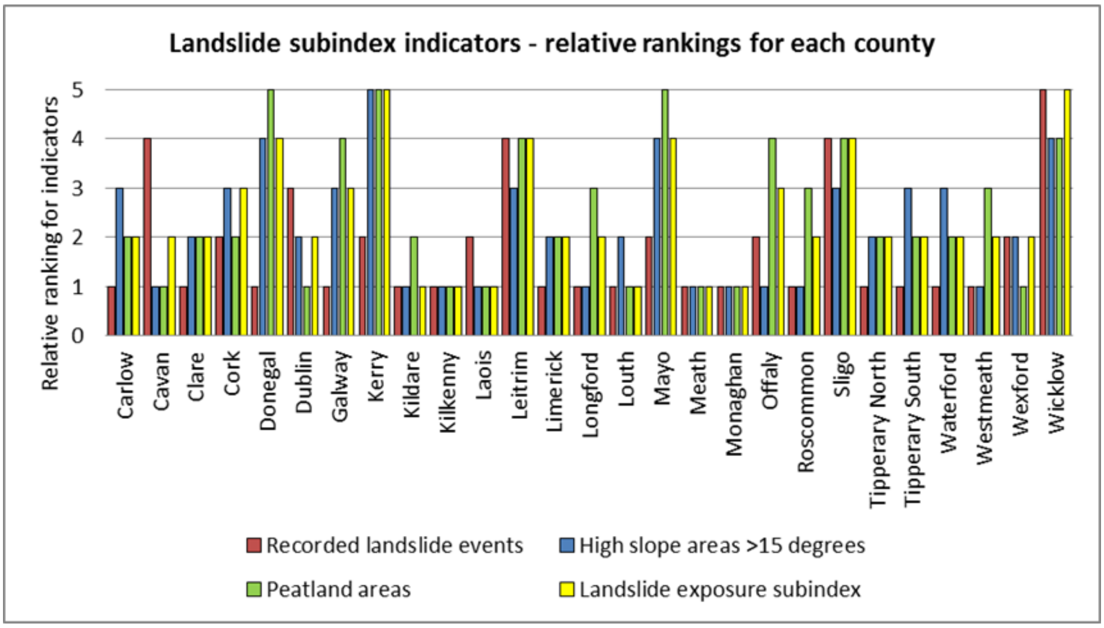
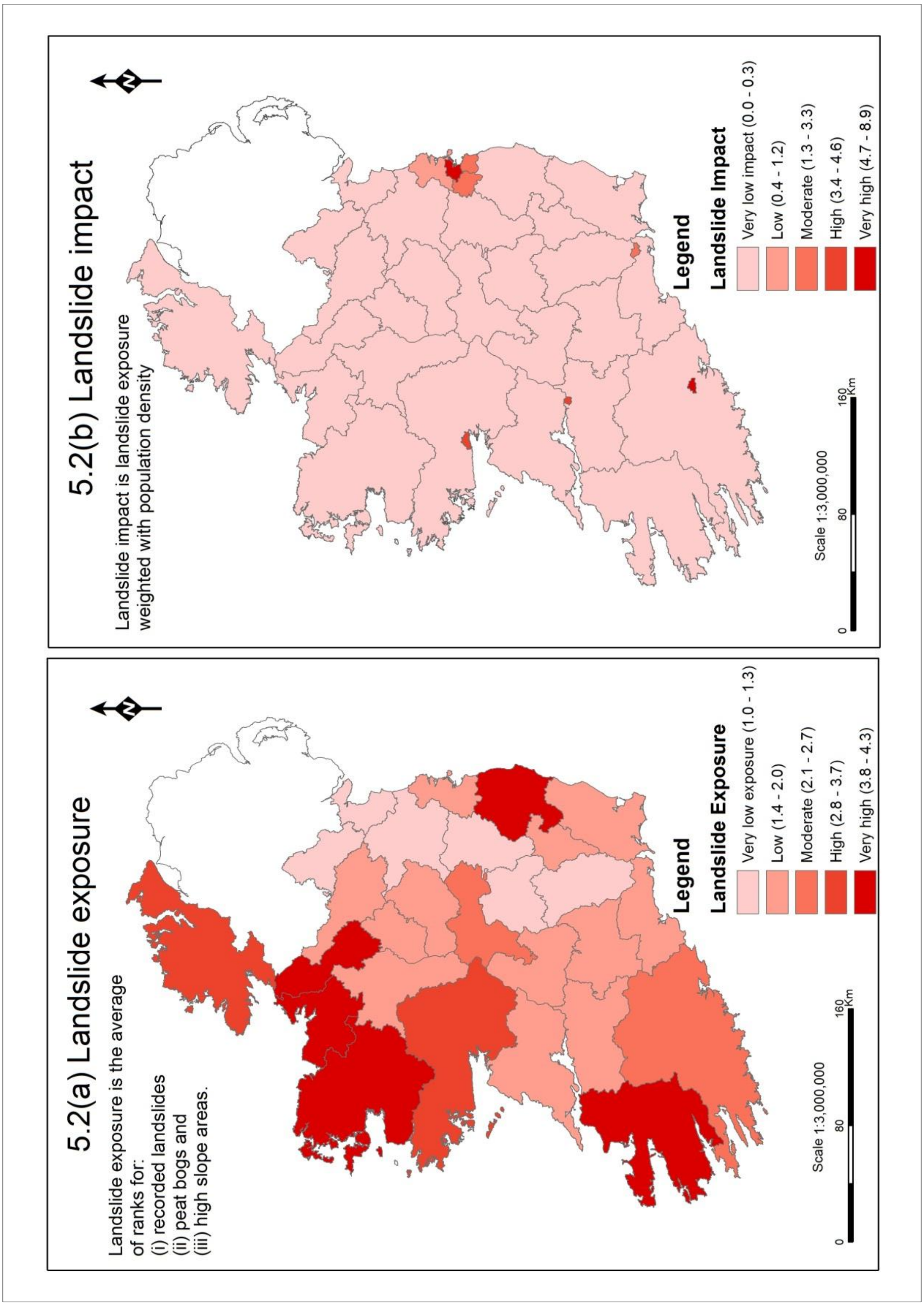


Figure 5.7 Landslide exposure sub-index: relative ranking by county

Considering population as shown in Map 5.2b, the very high landslide impact is in the cities: Dublin and Cork, and high impact in Limerick and Galway. Landslides impact transport and other infrastructure, even when there are few events (Creighton, 2006). For example, rail transport was disrupted in 2000, 2009, and 2014 due to landslides. Two landslides (2000 in Killiney and 2009 in Wicklow) disrupted rail service between Wicklow and Dublin City (O'Brien, 2000:4; Kane, 2009). In 2014 a small-scale landslide in Waterford disrupted rail services and required the tracks to be cleared at Waterford Train Station (Independent, 2014). These examples highlight the challenges local authorities face as they seek to safeguard people and the environment in their jurisdiction. In the Killiney case, private building development was a possible contributor to the landslide; however, there was no "blanket ban" on building near vulnerable railways, and the issue requires the consideration from planners and engineers (Independent, 2000). In the Waterford case, local conditions have large-scale implications for transport. Overall, there were 40 other landslides in the Greater Dublin Area. Similarly, there were 14 reported events in Cork.



Map 5.2a and .2b Landslide exposure and impact

5.2.1.3. Water supply

Water supply exposure varied throughout Ireland both for recorded water supplies at risk and for projected precipitation decreases. As Figure 5.8 shows, Kerry, Roscommon, and Sligo had the greatest exposure for public water supplies. The public water supplies will have limited effect on Irish local authorities as the climate change because responsibility is being transferred to the national Irish Water (to be completed by 2019).

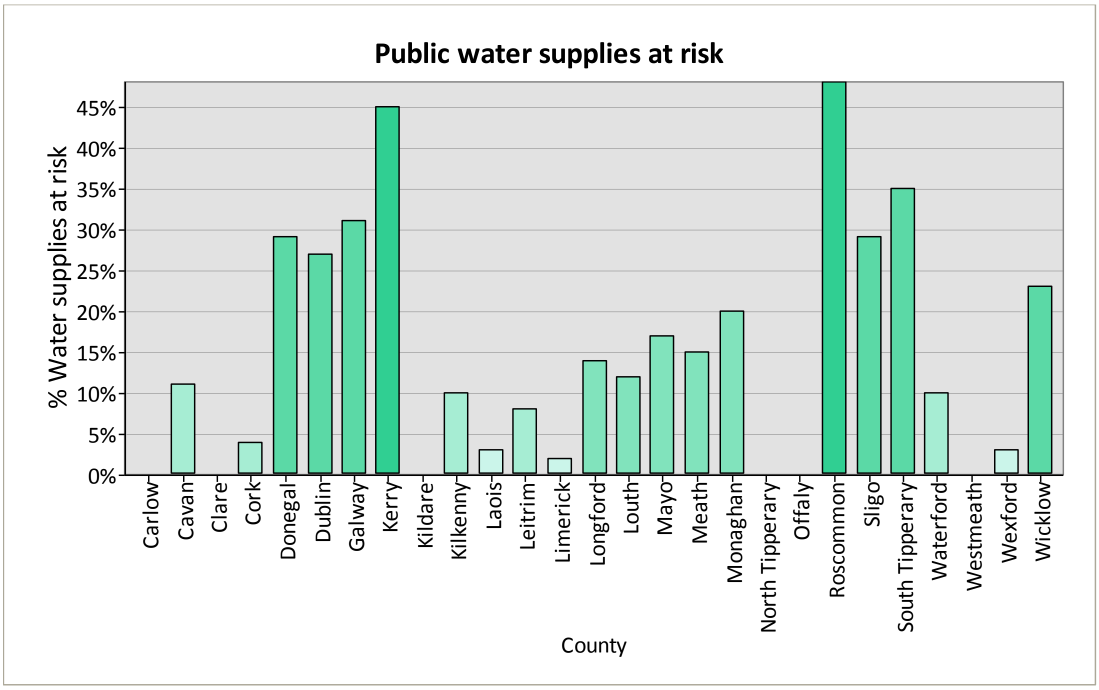


Figure 5.8 Public water supplies at risk (EPA RAL 2013 Q3)

This indicator highlights two important points about climate change vulnerability assessments: 1) how actions can change exposure to climate change, and 2) shifts in relative exposure as compared to absolute exposure. First, Galway demonstrates how actions can change exposure. In this regard, the 2013 Remedial Action List (RAL) has changed significantly since it was first established in 2008 as discussed in Chapter 2. Galway had extensive problems with its public water supplies and in 2010 80% of their water supply was on the Remedial Action List. Galway City and County Councils addressed the shortfalls and improved the exposure to less than 50% by the end of 2013 as shown in Figure 5.8.

Second, Wicklow demonstrates shifts in relative exposure as compared to absolute exposure. Wicklow's situation as regards its public water supplies did not change appreciably between 2010 and 2013 with both assessments showing similar percentages of the public water supplies at risk. This example shows the difference between absolute exposure (which did not change for Wicklow) and relative exposure which did change for Wicklow. In comparison to the other counties, Wicklow's exposure was moderate when considering the 2010 RAL, and very high when considering the more recent 2013 RAL. This highlights the importance of counties with lower relative exposure still taking actions to address climate change.

Summer precipitation decreases - the second indicator shown in Figure 5.9 - will be the greatest in Sligo, Monaghan and Cork. This compares the baseline (1961-1990) with mid-century (2031-2060) projected summer precipitation (June, July and August). There was a narrow range of values for decreased precipitation with an average of 8.1% decrease (range 5% - 11%). When adapting to climate change for water supply, it will be necessary to consider both current levels and decreases in precipitation.

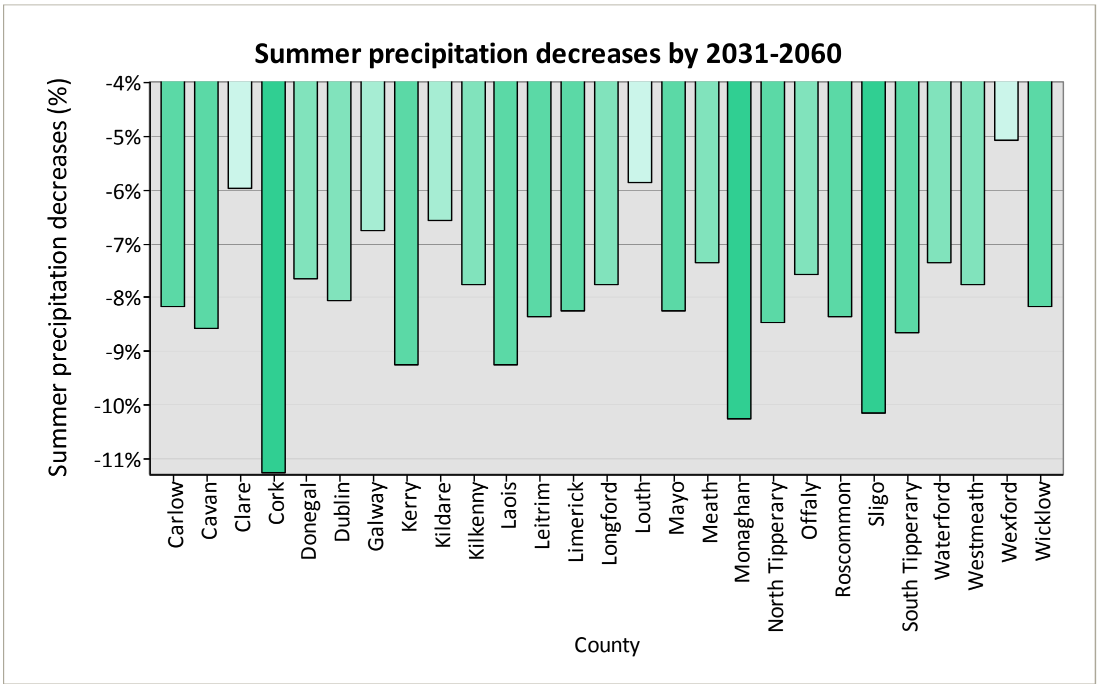


Figure 5.9 Summer precipitation decreases by 2031-2060 (C4I)

Overall, the greatest exposure for water supply will be in Dublin, Kerry, Monaghan, Roscommon, Sligo and South Tipperary as shown in Figure 5.10.

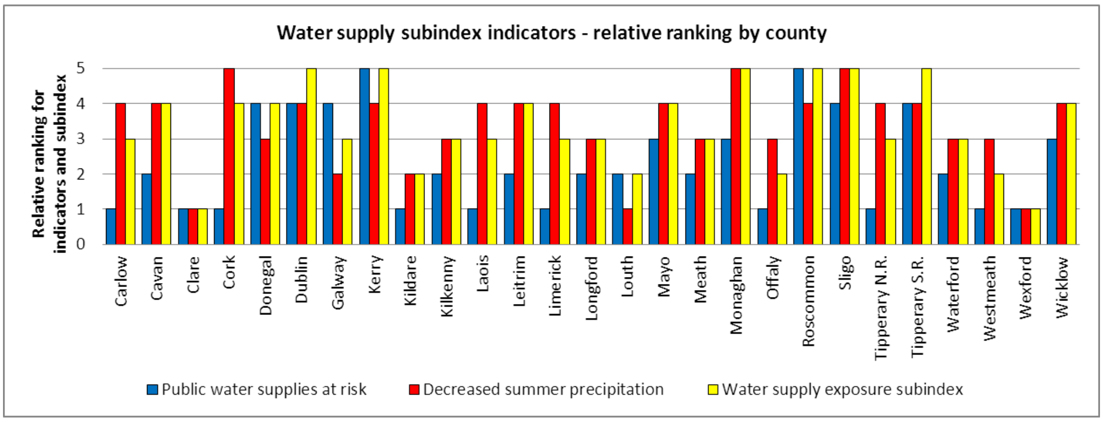
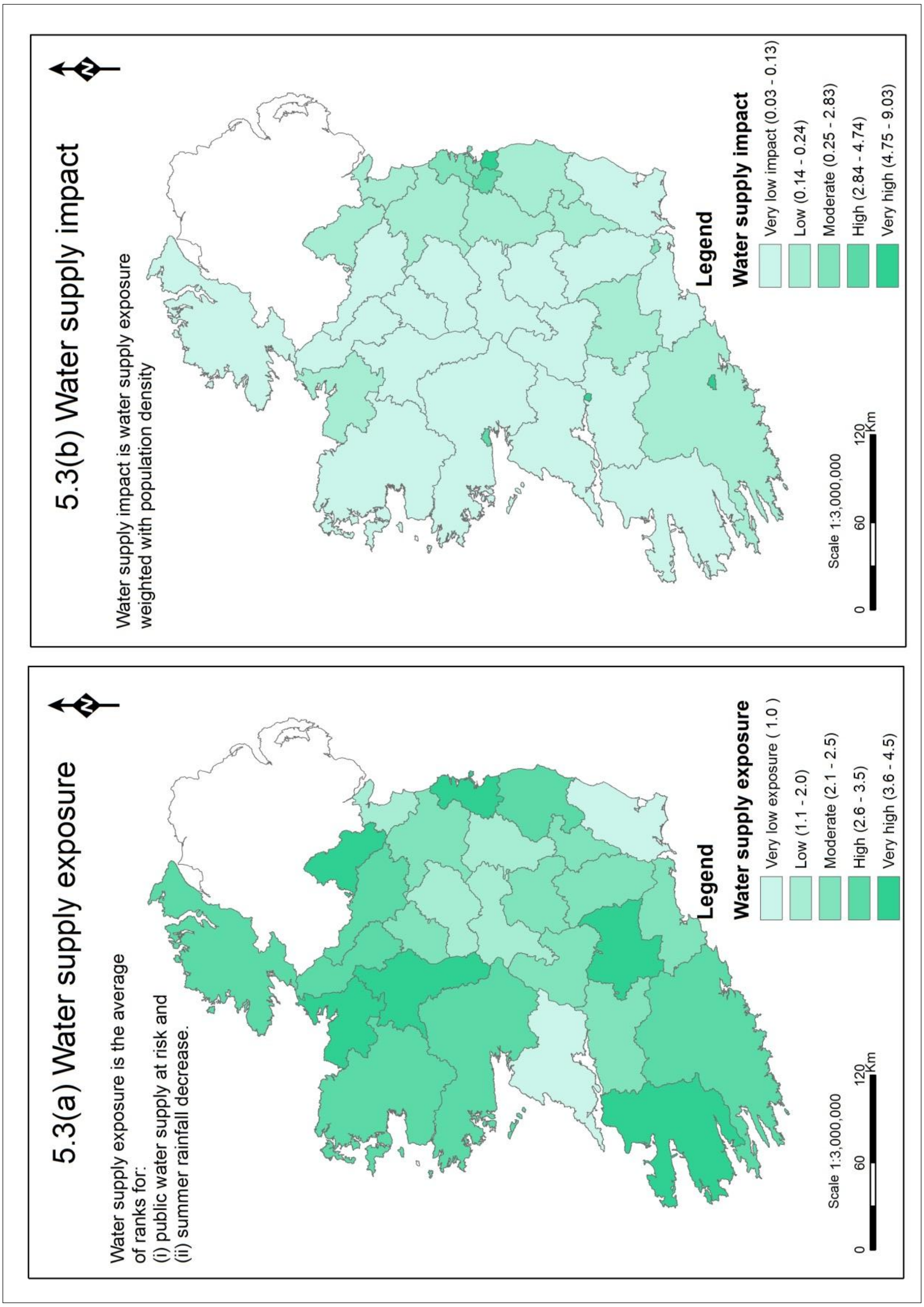


Figure 5.10 Water supply exposure sub-index: relative ranking by county

Map 5.3(a) references this picture of very high water supply exposure in those counties due to the high percentage of public water supplies requiring remedial action (Hayes et al., 2013) coupled with greatest decreases in summer precipitation by mid-century (2031–2060).

When considering population as shown in Map 5.3(b), the water supply impacts are greatest ('very high') in Dublin City, followed closely by high impacts in the cities of Cork and Limerick as well as Dún Laoghaire-Rathdown. This example demonstrates the usefulness of population density as a metric for evaluating sensitivity. For example, Dublin City's exposure is related to its high population density as well as its current water infrastructure. As in this case, current levels are challenging local authorities where water supplies have been recognised as falling short. Climate change will worsen water supply pressures in terms of quality and quantity.



Map 5.3a and 5.3b Water supply exposure and impact

5.2.1.4. Biodiversity

Biodiversity exposure varied throughout Ireland for the indicators (protected sites and protected species) and for overall exposure. For both these indicators low exposure is associated with a greater percentage of protected areas and greater number of protected species. The height of the bars in both these figures is still based on the individual county's information since this shows the differences even within a given category. Using protected areas as an example, the five counties in the very low exposure category range from Donegal's 40% to Kerry's 60%.

As Figure 5.11 shows some counties have large percentages of their land as designated protected sites and therefore these counties have very low exposure. In some cases such as the smaller counties of Carlow and Kildare, the inverse is true because less than 6% of their land is designated as protected. More detailed research could include other factors such as barriers to species migration and instances where development has been allowed within protected areas.

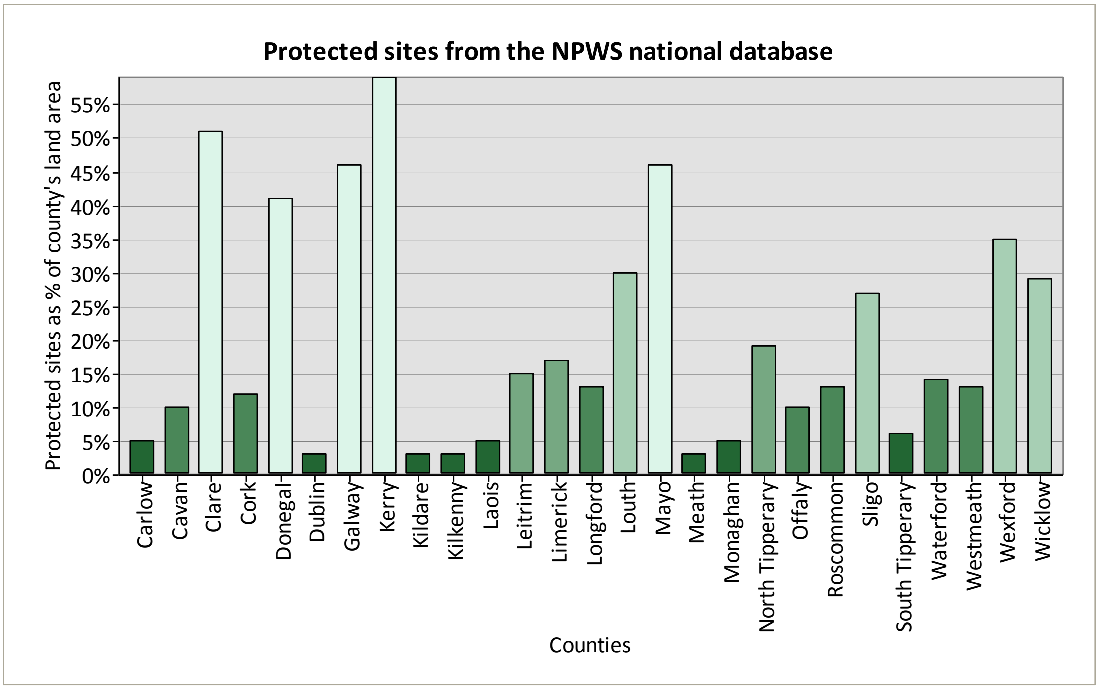


Figure 5.11 Protected Sites (NHA, SAC and SPA) by County (NPWS, 2012)

The second indicator of protected species shows which counties will face challenges related to biodiversity exposure. As Figure 5.12 shows, some counties have a very high number of protected species (26-37) while others have very few (6-10). As with the other sectors, all counties will need to address climate impacts on biodiversity.

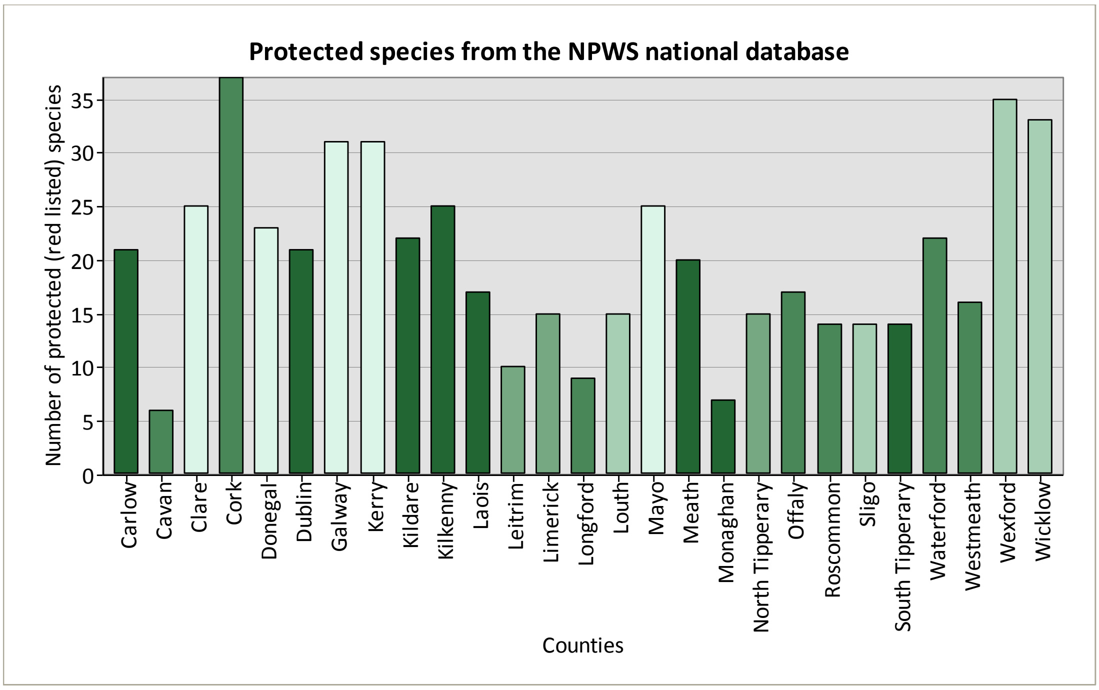


Figure 5.12 Protected species (Red Listed) by County (NPWS, 2012)

As Figure 5.13 shows, the combined indicators result in high overall exposure for some counties with mixed levels of indicator exposures. For example, some counties such as Carlow have few protected sites (very high exposure ranking of 5) coupled with a moderate number of Red Listed species (moderate exposure ranking of 3) which average to an overall high biodiversity exposure. The counties that have very high overall exposure generally have very high exposure for one of the two indicators, and high exposure for the second indicator. The counties with overall very high exposure are Cavan, Laois, Longford, Monaghan, and South Tipperary.

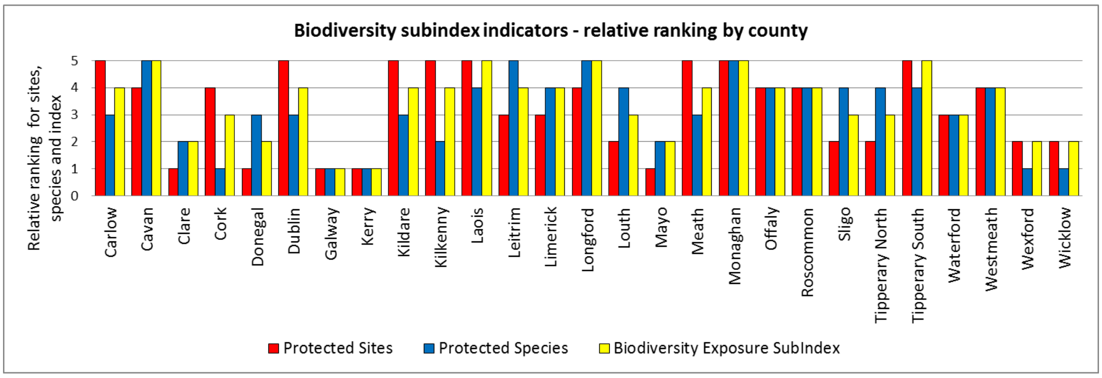
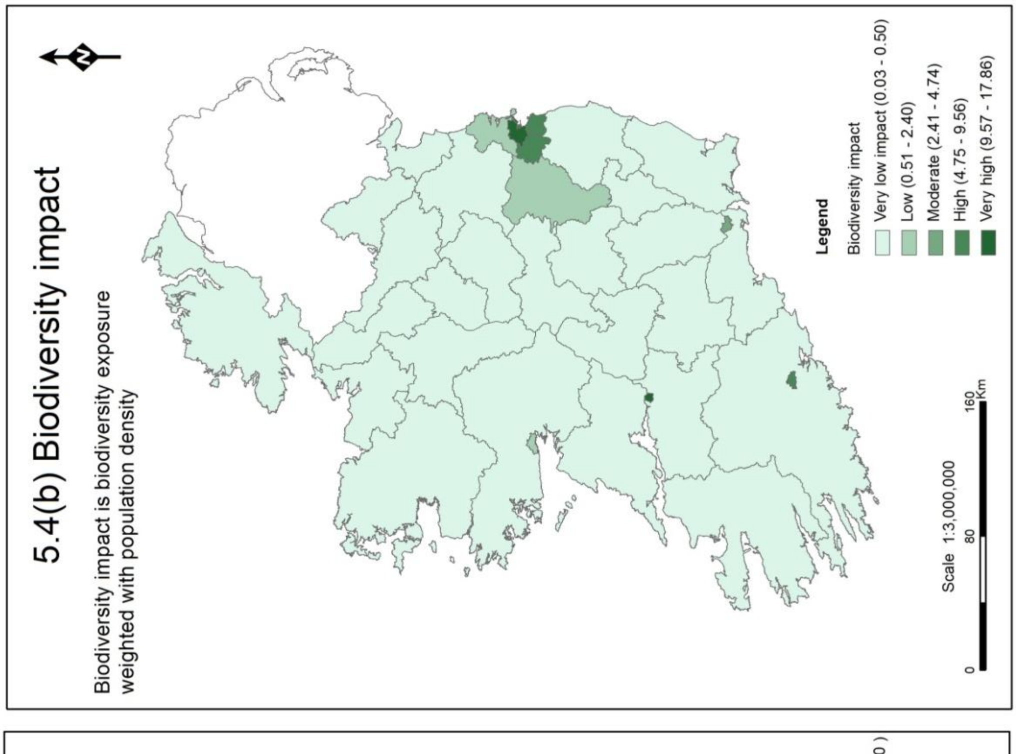


Figure 5.13 Relative rankings for the indicators

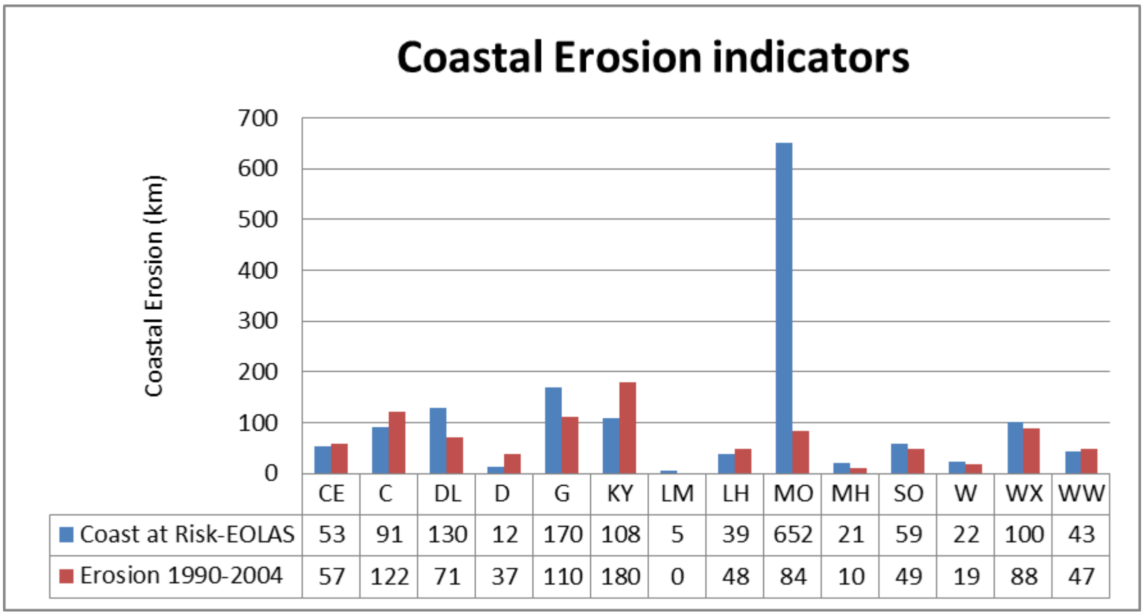
As Map 5.4(a) shows, the greatest exposure is for inland counties as is also reflected above in Figure 5.13. When considering population (Map 5.4b), there is 'very high' impact in the cities of Dublin and Cork as well as 'high' impact in Dún Laoghaire-Rathdown and Limerick City.



Map 5.4a and 5.4b Biodiversity exposure and impact

5.2.1.5. Coastal erosion

The exposure for coastal matters is, of course, limited to coastal counties, and again some of these counties have greater exposure than others. The coastal erosion exposure was evaluated with coastline at risk of erosion and confirmed erosion trends. Data from the two sources were similar except for County Mayo as shown in Figure 5.14, where the 1992 EOLAS study commissioned by the National Coastal Erosion Committee is shown in blue, and the 2004 EUROSION study is shown in red. Cork and Kerry engineers identified fewer coastlines at risk in the EOLAS study as compared to researchers in the EUROSION study for confirmed erosion trends (shown in red). On the other hand, most counties estimated more coastlines at risk in the EOLAS study than researchers reported in the EUROSION study.



	CE	C	DL	D	G	KY	LM	LH	MO	MH	SO	W	WX	WW
Coast at Risk-EOLAS	53	91	130	12	170	108	5	39	652	21	59	22	100	43
Erosion 1990-2004	57	122	71	37	110	180	0	48	84	10	49	19	88	47

Figure 5.14 Coastal erosion indicators comparison

When considering coast at risk, Figure 5.15 shows that Mayo has very high exposure within the relative ranking framework, and other western counties and Wexford had high exposure. At the same time, Wicklow only had moderate exposure even though there are known problems with coastal erosion in this county. This reflects the limitations of the dataset because how aggressive the erosion is not included as part of the assessment.

Conversely, erosion trends were most widespread in Kerry according to the EUROSION study (see Figure 5.16). There was also high exposure in other western counties (Galway, Cork and Mayo) as well as Wexford in the east.

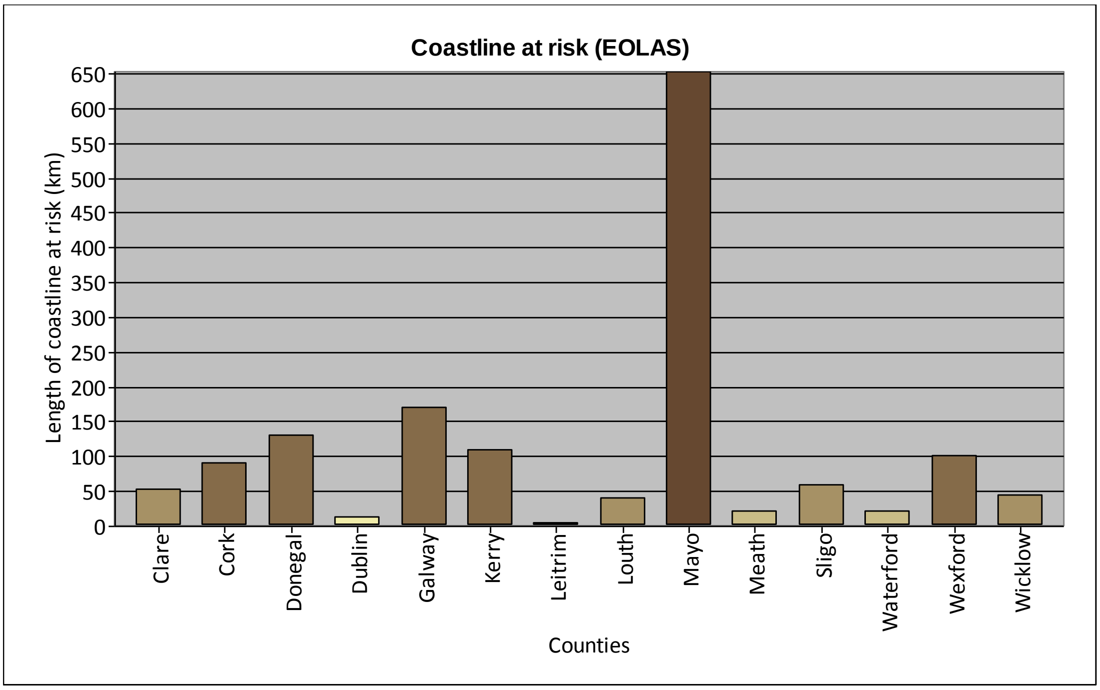


Figure 5.15 Coast at risk of erosion

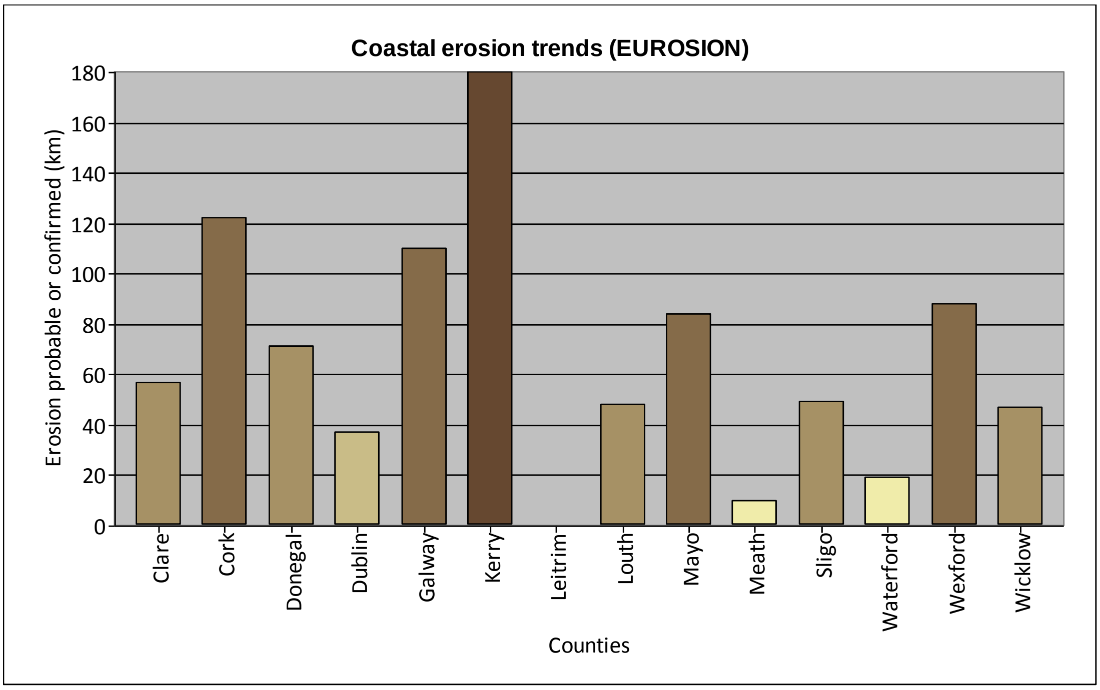


Figure 5.16 Recorded erosion trends between 1990 and 2004

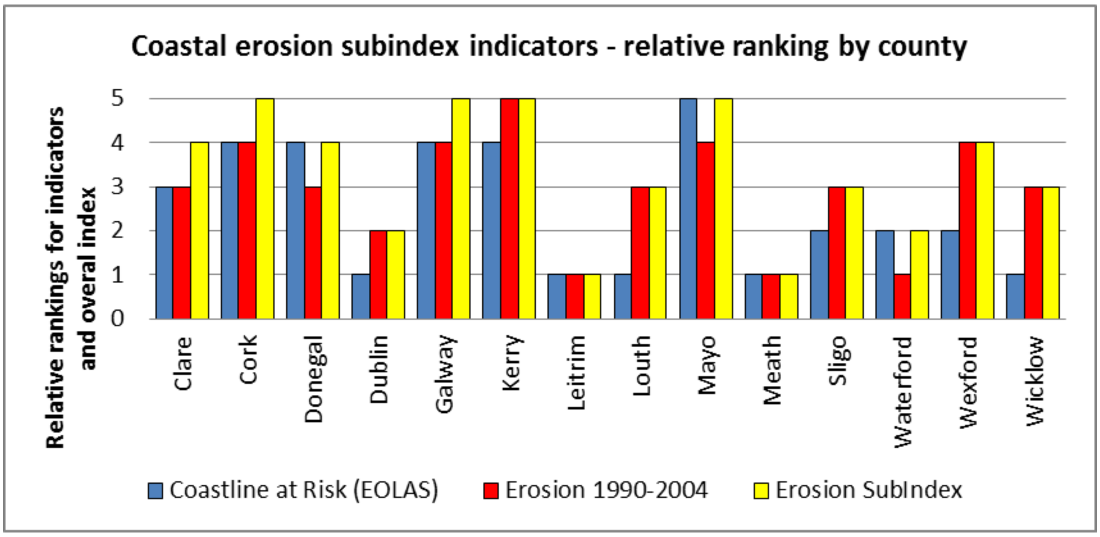
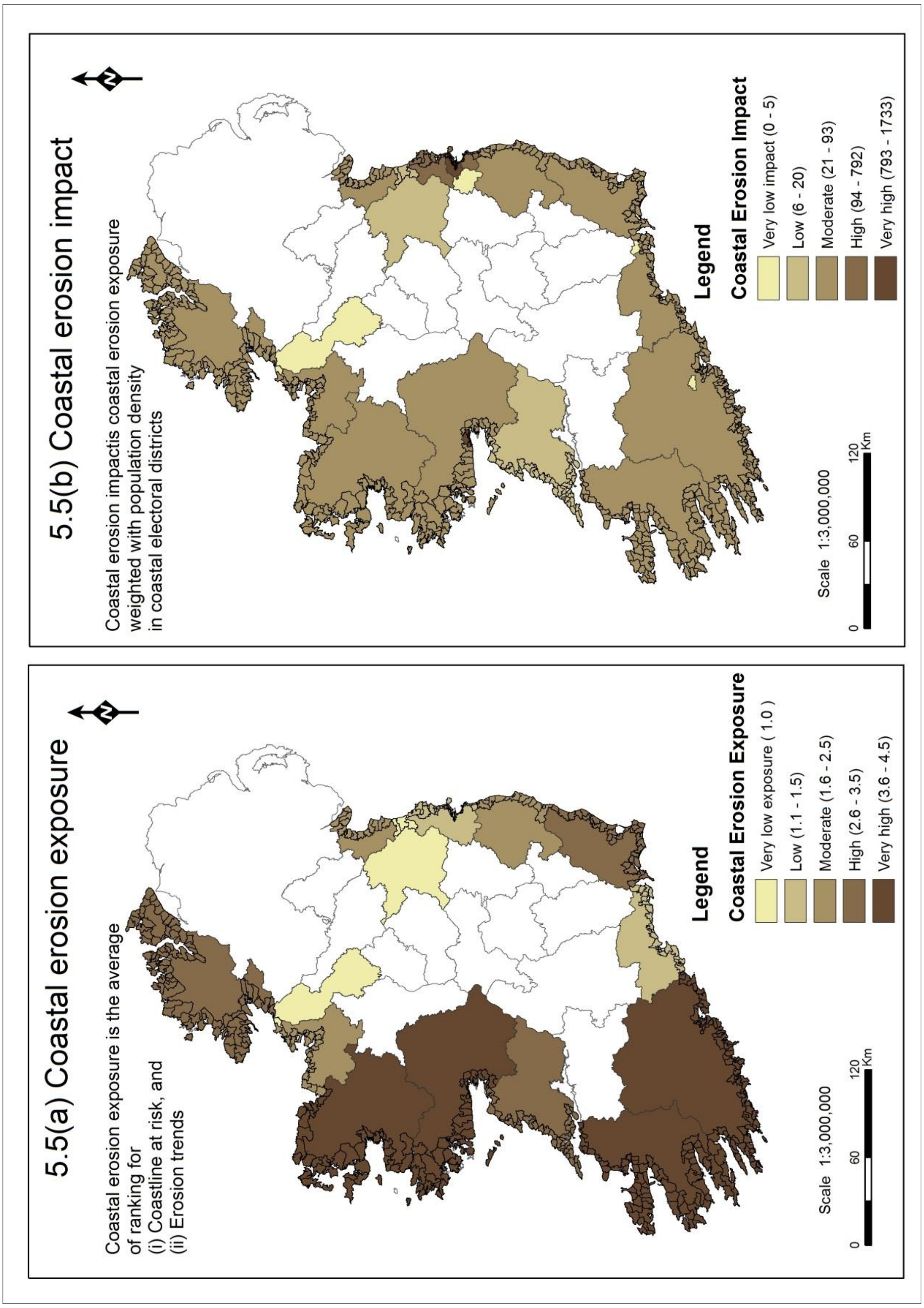


Figure 5.17 Relative rankings for the indicators and sector

As Figure 5.17 shows, the greatest exposure for coastal erosion was in Cork, Galway, Kerry and Mayo. Conversely, the west coast has been considered "more resilient than the east coast by virtue of its harder physical structure and abundant sediments" and "the areas most vulnerable to coastal erosion are the soft coastlines of the east coast between County Down and County Wexford" (DELG 2001:15,16). This focus has been carried through with the OPW Coastal Protection Strategy Study which has focused on the east coast. At the same time, the funding for minor coastal protection between 2009 and 2011 was greater for western counties than for eastern counties (€1,981K and €724K respectively) (OPW, 2014a; OPW, 2014b; OPW 2014c). Similarly for the 2013/2014 winter storms, more funding was allocated to local authorities in western counties than those in the east (€16.7M for western counties, and €2.8M for eastern counties (OPW, 2014d).

Coastal erosion exposure is very high in Cork, Galway, Kerry and Mayo followed closely by high exposure in Clare, Donegal and Wexford (Map 5.5a) due to coastline at risk and recorded erosion trends. The exposure of cities (Cork, Limerick and Waterford) located on estuaries is not represented in this study.

However, when considering population, the greatest impact (shown on Map 5.5b) will be in local authorities with very high impact (Galway City) and high impact (Dublin City and Dún Laoghaire-Rathdown).



Map 5.5a and 5.5b Coastal erosion exposure and impact

5.2.1.6. Sea level rise

Similar to the coastal erosion exposure, sea level rise exposure was evaluated only for coastal counties. Sea level rise will affect coastal counties through flooding of low lying areas and through contamination of aquifers due to saltwater inundation. These effects were evaluated by examining low lying areas (where elevation was less than 1 metre above sea level), high storm surge projections, and coastal aquifers.

As Figure 5.18 shows, low-lying areas were greatest in Cork and Kerry along the coastline even taking into consideration the mountainous terrain in these counties since most of the low-lying areas are adjacent to the coast.

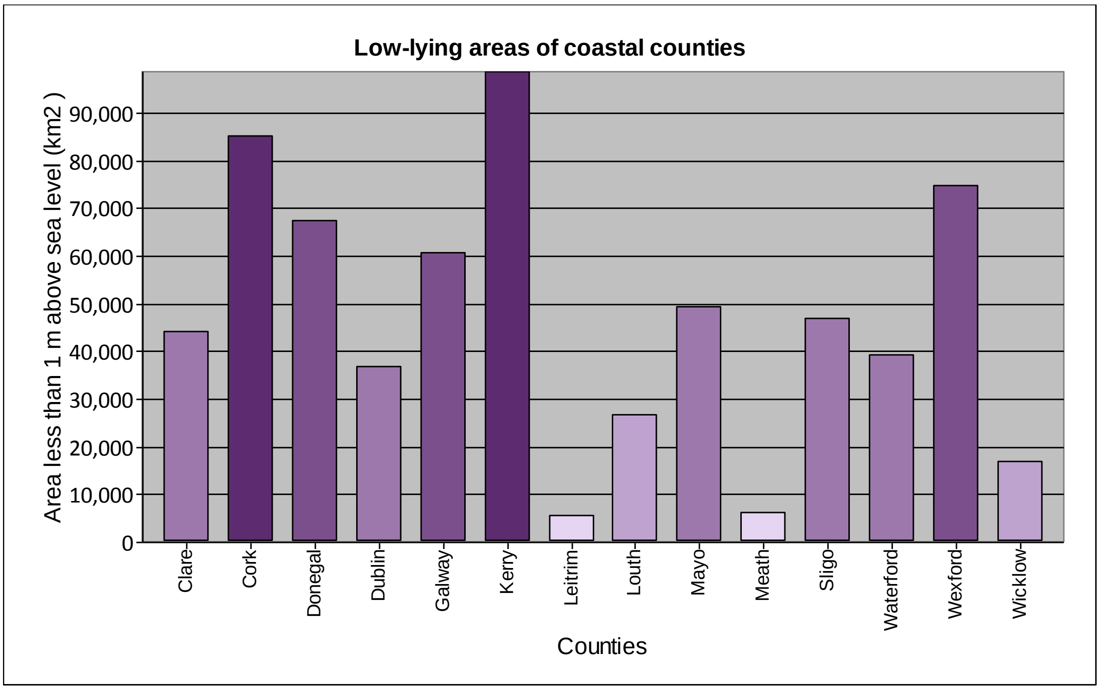


Figure 5.18 Low lying areas in coastal counties

The increases in storm surge height show the greatest exposure in the western counties of Clare, Galway, Leitrim, Mayo and Sligo as shown in the darkest shade in Figure 5.19 below. These results should be considered within the context that the C4I projections only included 13 data points for Ireland (see Map A.3 in Appendix A).

When considering coastal aquifers, the greatest exposure was in the western counties of Clare, Cork and Kerry as shown in the darkest shade in Figure 5.20. This indicator suggests those counties which will likely face challenges from saltwater inundation but does limits the assessment to those aquifers that were classed by the GSI as regionally and locally important.

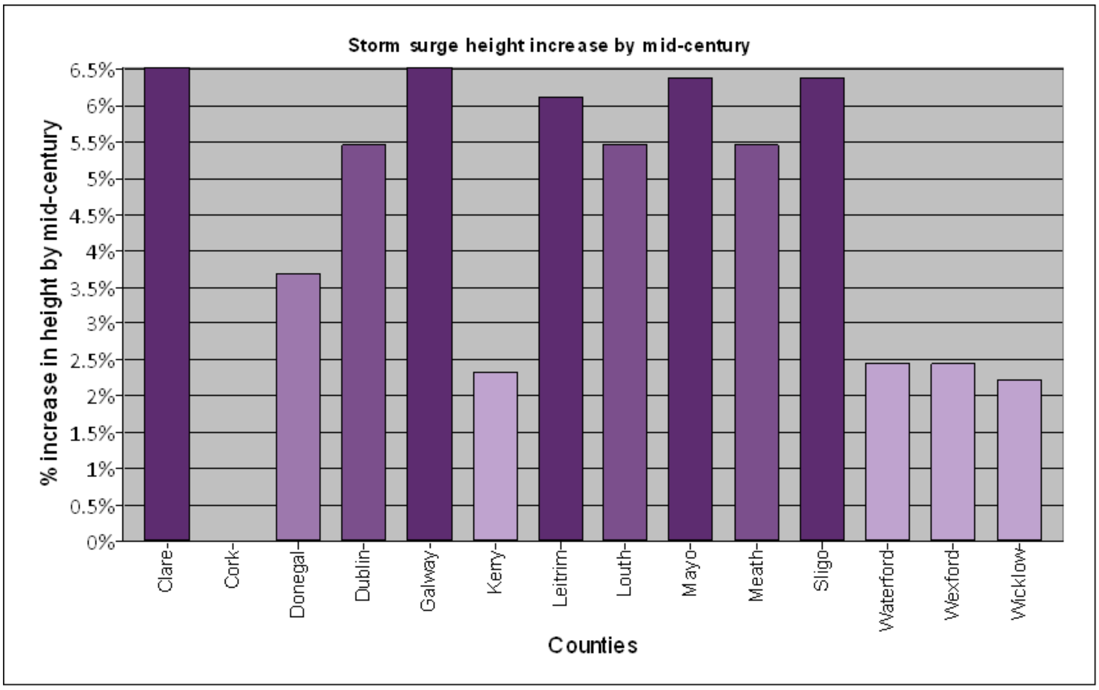


Figure 5.19 Increases in height for extreme storm surges by mid-century

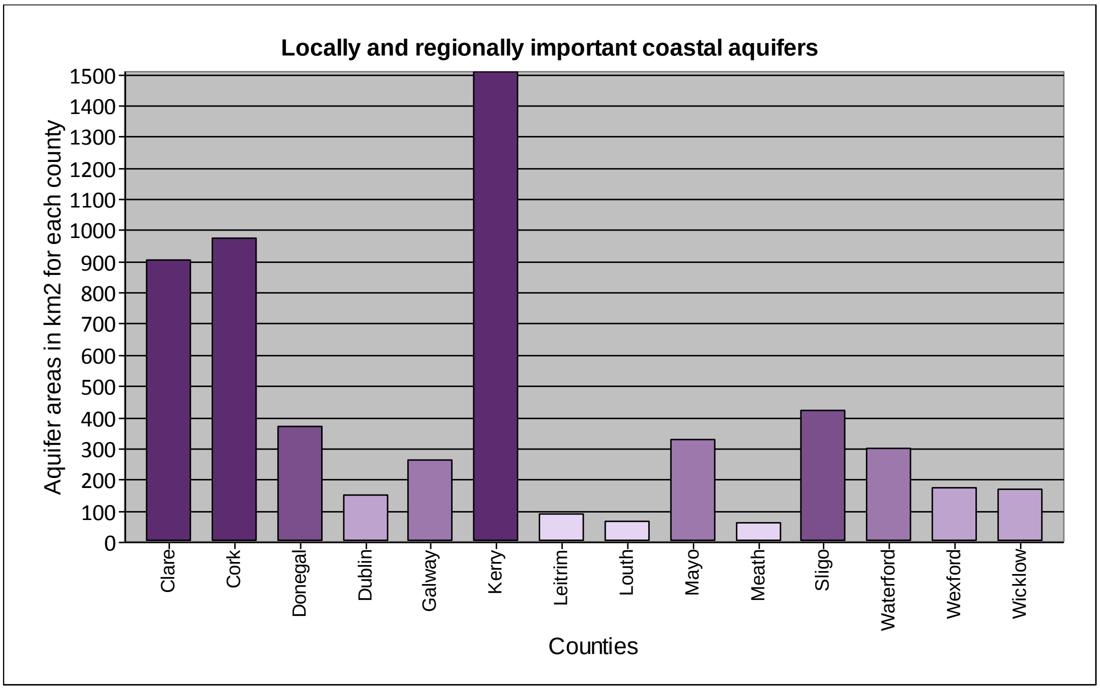


Figure 5.20 Locally and regionally important coastal aquifers

These indicators provide some information about which counties will have greatest exposure to sea level rise as shown in Figure 5.21 below. Because of the very high ranking for multiple indicators, Clare and Kerry have very high exposure overall; as do those counties which have very high and high exposures for multiple indicators (Galway and Sligo). In the cases where there were moderate or high exposures for a given indicator, the counties are still like to face challenges related to sea level rise. These challenges are supported by the costs incurred due to the winter 2013/2014 storms where the OPW funded €19.6M to both western and eastern counties for coastal protection repairs as discussed regarding coastal erosion exposure (OPW, 2014d).

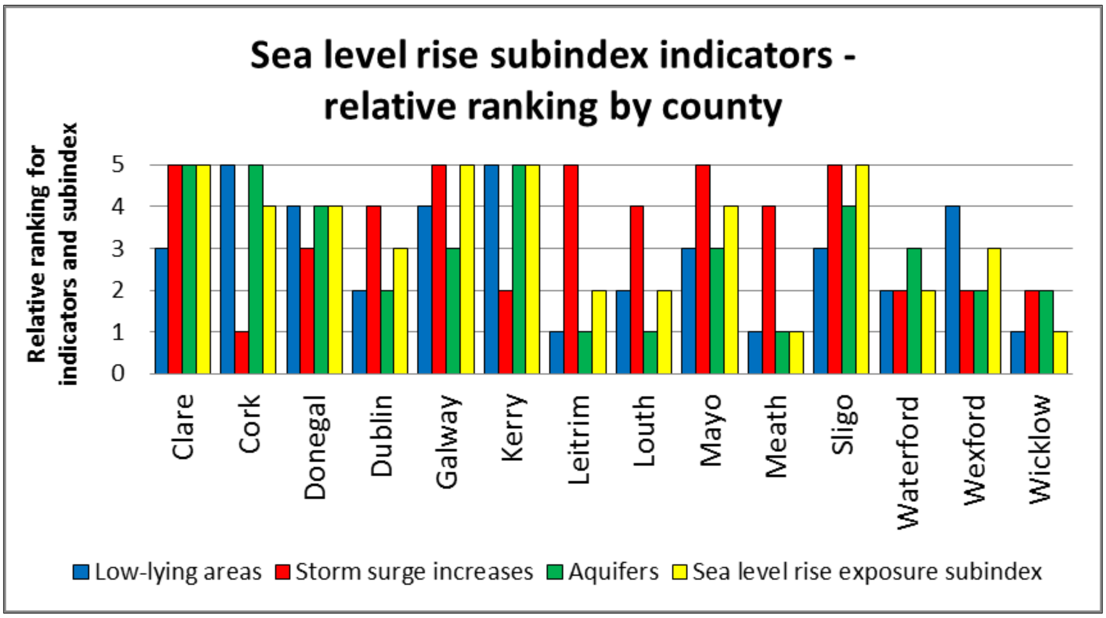
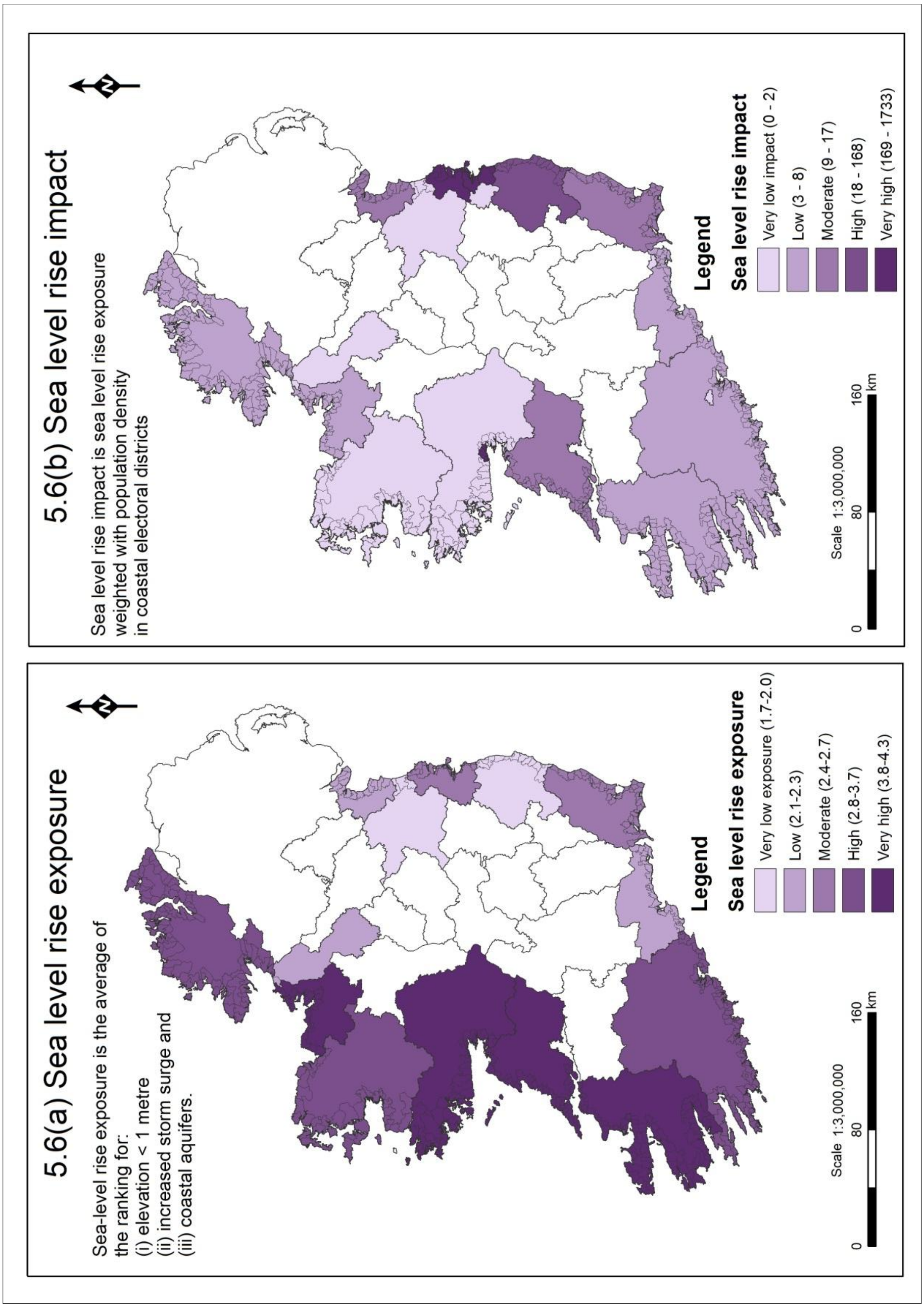


Figure 5.21 Sea level rise sub-index indicators - relative ranking by coastal county.

These figures are represented below in Map 5.6a which shows greater exposure generally in the west of Ireland as compared to the eastern counties.

When considering population (Map 5.6b), the greatest impact will be in local authorities with 'very high' impact (the cities of Galway and Dublin including Dublin City, Dún Laoghaire-Rathdown and Fingal) and 'high' impact (Wicklow).



Map 5.6a and 5.6b Sea level rise exposure and impact

5.2.1.7. Combined physical exposure and impact

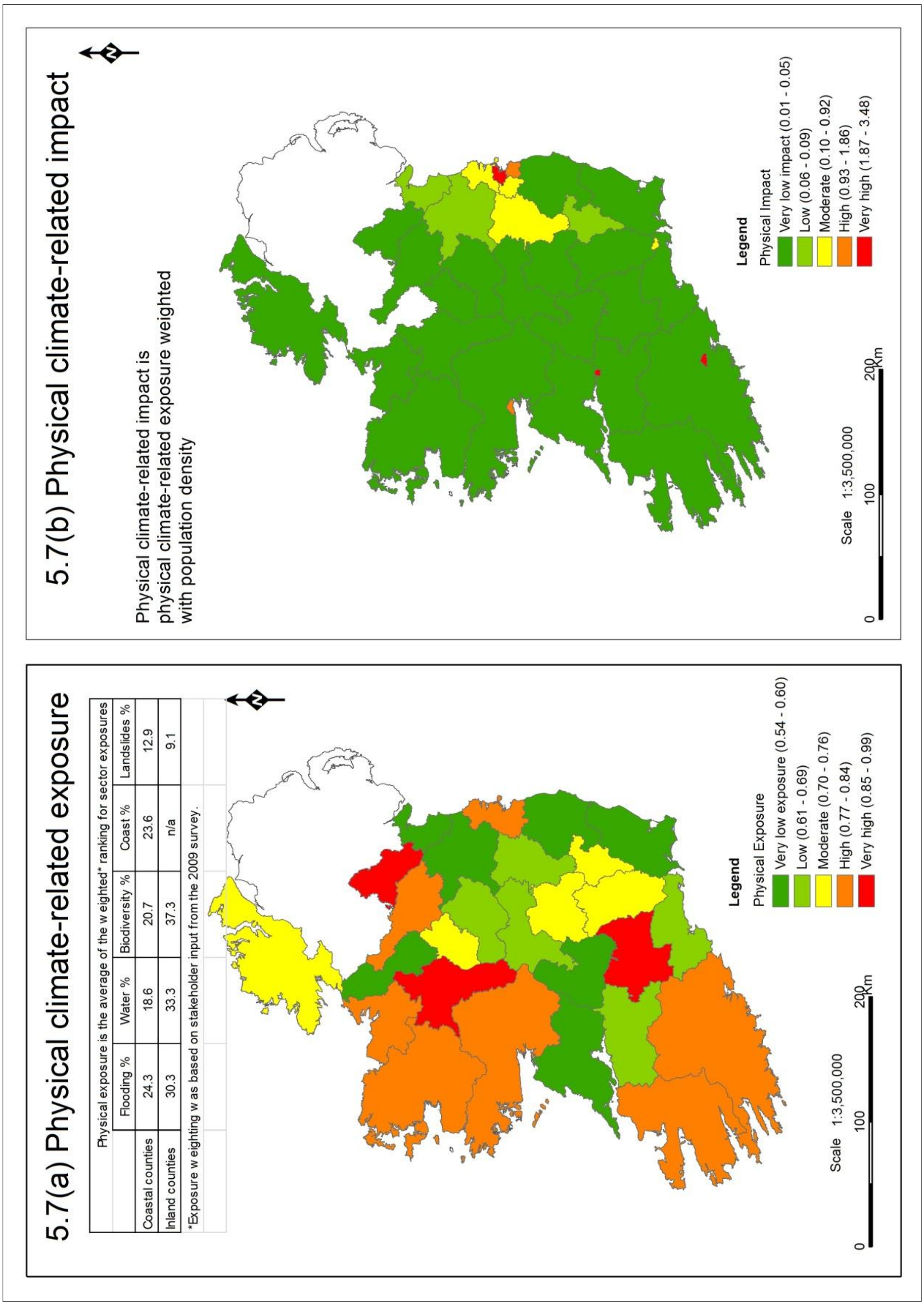
This section presents results with a very different approach. As a separate exercise from the foregoing exposures and impacts, each council's overall physical climate exposure and impact was assessed with the weighted physical impacts as shown below in Table 5.1 and described in the methodology section (Chapter 3). As shown on Map 5.7a, overall climate exposure is 'very high' in Cork, Galway Kerry, Kilkenny, Mayo, and South Tipperary as well as 'high' in Carlow, Roscommon, and Sligo.

Table 5.1 Sector weighting based on stakeholder input

		Sectors				
Councils[1]	Impact levels[2]	Flooding	Water	Biodiversity	Coastal[3]	Landslides
Coastal councils (n=19)	High	30 (15*2)	18 (9*2)	20 (10*2)	28 (14*2)	6 (3*2)
	Limited	4 (4*1)	8 (8*1)	9 (9*1)	5 (5*1)	12 (12*1)
	None anticipated	0	0 (2*0)	0	0	0 (4*0)
	Total	34	26	29	33	18
	Weighting factor	0.243	0.186	0.207	0.236	0.129
Inland councils (n=7)	High	6 (3*2)	8 (4*2)	4 (2*2)	0	0
	Limited	4 (4*1)	3 (3*1)	5 (5*1)	0	3 (3*1)
	None anticipated	0	0	0	0 (7*0)	0 (4*0)
	Total	10	11	9	n/a	3
	Weighting factor	0.303	0.333	0.273	n/a	0.91

[1] Councils include participants in the 2009 survey who indicated anticipated impact levels.
[2] Responses are multiplied by the value listed below for each level shown as number responses (value of response): high impact=2, limited impact=1, no anticipated impact=0
[3] Coastal includes erosion and sea level rise

Again, in terms of population, Map 5.7b shows that overall climate impact is very high in the cities Cork and Dublin, and high in Dún Laoghaire-Rathdown and the cities of Galway and Limerick. Together the exposure as shown in Map 5.7a and impact as shown in Map 5.7b highlight the areas where Ireland will be exposed to climate change as well as the very high impact areas where the greatest number of people will be affected.



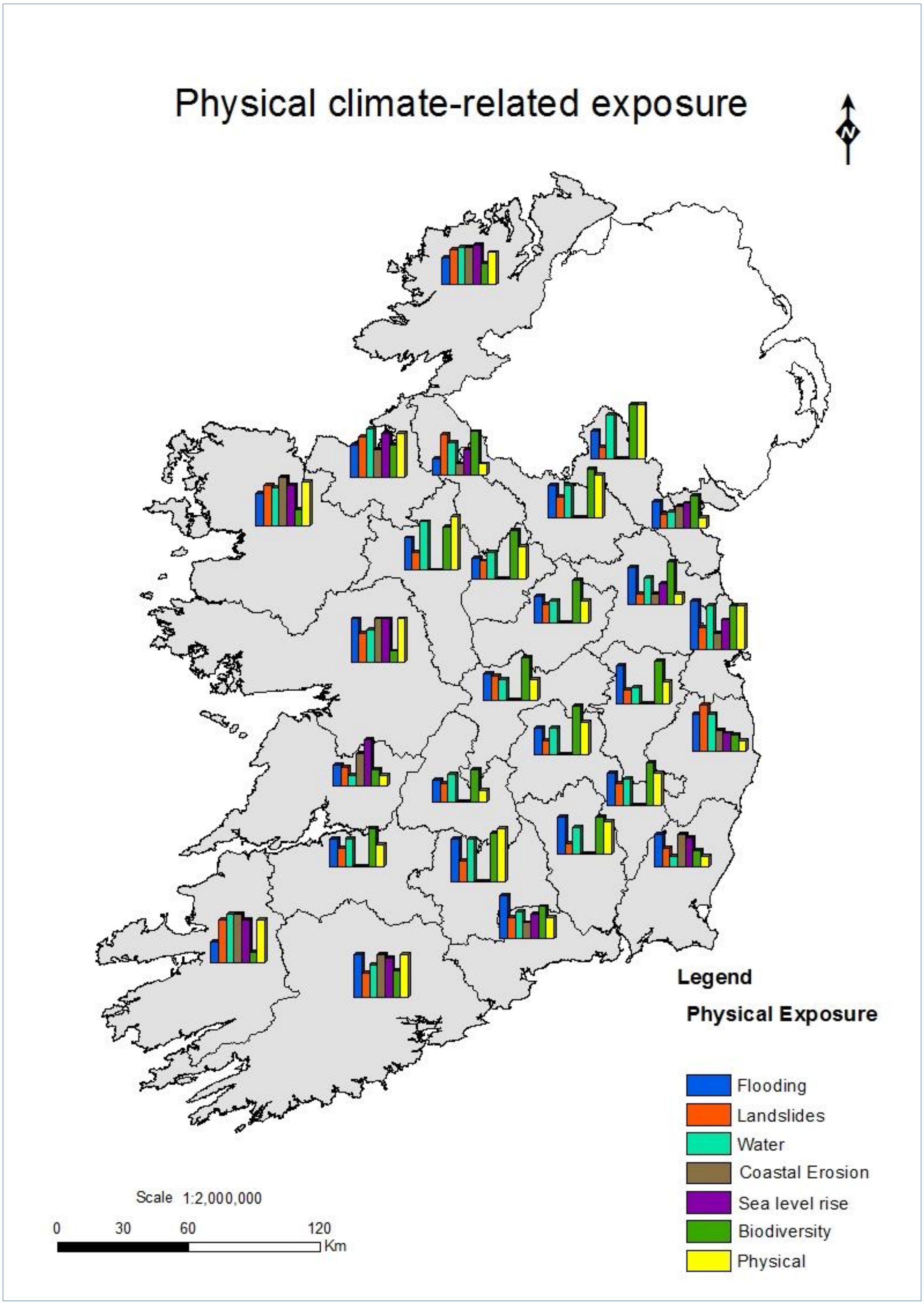
Map 5.7a and 5.7b Physical climate-related exposure and impact

5.2.1.8. Discussion physical exposures and impacts

While the need to plan for climate change is pressing even in the face of uncertainties, these results are presented with the cautionary note regarding the multiple sources of uncertainty related to the indicators and the sectors. The indicators have inherent uncertainties, as discussed in Chapter 3, due to data reporting practices, compromises between details and aggregated information, and parts of processes that are not captured by the indicators. In addition, there are further uncertainties in relation to the interactions between the different sectors and future changes beyond those projected by the climate models. These sources of uncertainty mean that the results should be used as a starting point for discussion rather than as a definitive assessment of future climate change risk within a given local authority or even throughout Ireland. These results indicate areas of concern for local authorities and must be coupled with the local knowledge and further detailed climate studies in order for effective planning on climate change. Overall though, the pressing need for adaptation requires that local governments start planning and adapting now rather than waiting for certainty of specific changes.

5.2.2. Summary of physical exposures and impacts

As shown in Map 5.8, exposure levels vary throughout the country for individual sectors and for overall physical exposure. A summary table of the greatest exposures listed by sector is included in Appendix D (Table D.5). Different local authorities have ‘very high exposure’ or 'very low exposure' due to local variations in climate change projections, recorded events, and land attributes. In considering the different sectors, flooding exposure tended to be greater in the eastern and southern parts of the county as well as in Galway. Landslide exposure was greatest in Wicklow and Kerry as well as in the northwest of the country. Water supply exposure was very high in counties scattered around the country, and high in the northwest part of the country. Biodiversity exposure was greatest in inland counties. The coastal concerns, erosion and sea level rise, were greatest along the western coast of the country. In considering overall physical exposure, the western counties of Mayo, Galway, Kerry and Cork as well as North Tipperary and Kilkenny had the greatest exposure.



Map 5.8 Map with bar graphs for all physical climate-related exposure

Conversely, impact levels were less varied because population density was used as the sensitivity metric. This assessment offers a starting point which can be expanded through a more nuanced sensitivity analysis. Taking this into account, the cities of

Dublin and Cork had the greatest impact levels most frequently (very high impact), followed closely by the other cities of Galway, Limerick, and Dún Laoghaire-Rathdown (high impact). In the case of coastal impacts, the distribution was different. For coastal erosion, the greatest impact level was in Galway City (very high impact), followed closely by the other city areas of Dublin and Dún Laoghaire-Rathdown. For sea level rise, the greatest impact levels were in the densely-populated Dublin City, Dún Laoghaire-Rathdown, Fingal and Galway City (very high impact), followed closely by Wicklow. The other cities (Cork, Limerick and Dublin) showed low impact levels because they have no coastal electoral districts, which were the population densities used for the coastal matters. Therefore, excluding coastal impacts, the greatest impacts for physical climate exposures were in the cities of Cork and Dublin.

5.2.3. Adaptive capacity evaluation

When they lack capacity, local authorities face more challenges and are more exposed to the impacts of climate change. This capacity is difficult to measure and predict because it is the intangible, evolving "ability of a system to adjust to climate change" (Parry et al., 2007:869). Given this caveat, the capacity of local authorities to address climate change was measured by their expressed capacity and available resources. Their expressed capacity was evaluated through mainstreamed measures in development plans and stand-alone climate change strategies. Available resources to address climate change were based on forward planning staff numbers in each council. This section considers the three metrics, relates it to the population likely to be affected, and concludes with a description of the overall adaptive capacity.

5.2.3.1. Development Plan Added Measures

Local authorities have mainstreamed climate change into their policies to varying degrees as shown in Map 4.1. The development plans, as their main strategy document, are the blueprint for development and set the guidelines for individual planning applications. These development plans meet minimum statutory requirements and some go further to include added measures that fall within the scope of their responsibilities, such as protecting the environment. A review of the development plans revealed that most local authorities are including added measures that expressly link climate change with specific sectors. As noted in Chapter 4, the number of added measures was evaluated by sector and the number for each county is comprised of the number of sectors for which they included added measures. These results do not capture how extensively each sector was addressed with those added measures, i.e. a local authority might have many measures for a given sector while another local authority had fewer. These differences were discussed more fully in Chapter 5 with details about the specific measures that were adopted for each sector.

5.2.3.2. Contributing factors affecting adaptive capacity

The wide variation of climate-related measures suggested that contributing factors were affecting local authority actions: physical exposure, anticipated impacts, regional affiliation, date of development plan, and population density.

Physical exposure

In Ireland physical exposure has not determined local authorities' preparations for climate change. As Figure 5.22 shows, there was a lack of association between physical exposure levels and the actions taken by local authorities.

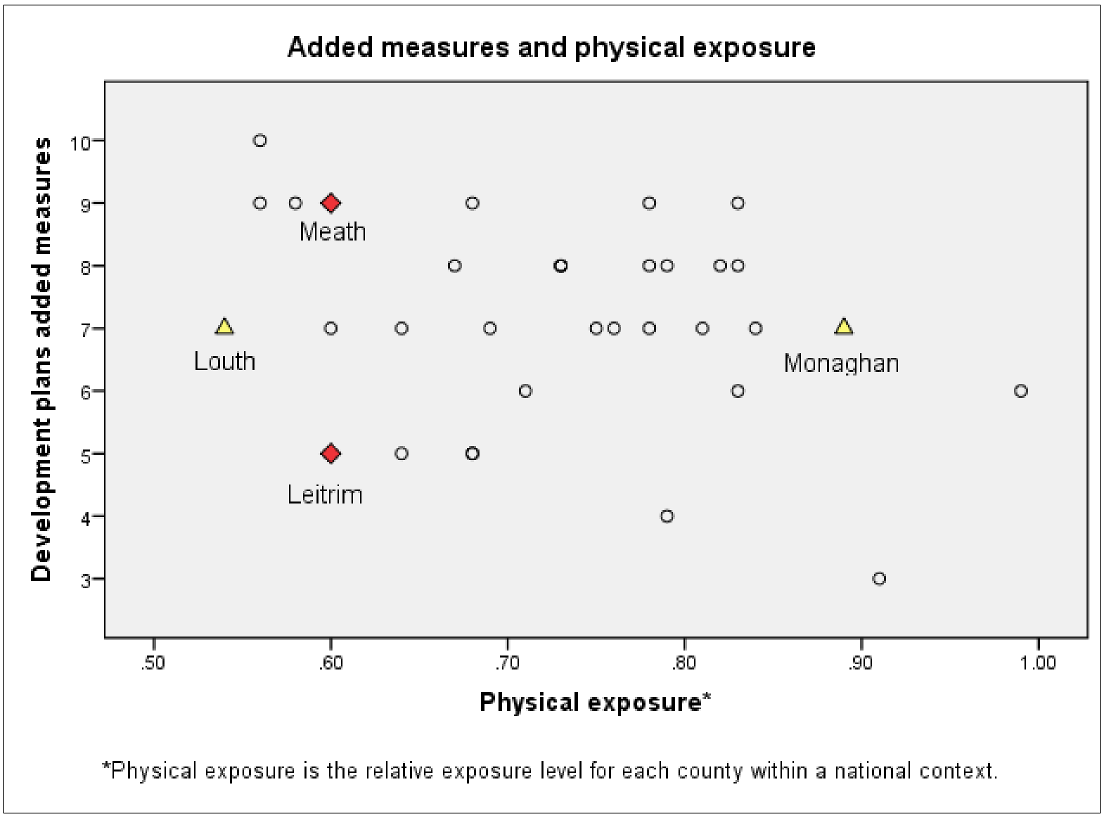


Figure 5.22 Association between added measures and physical exposure.

This lack of association is illustrated by two results. First, the same number of measures was adopted by local authorities with different levels of physical exposure. Second, local authorities with similar exposure levels had adopted different numbers of measures. To expand on the first point, Meath and Leitrim (shown in Figure 5.22 with the red diamonds) had similar physical exposure levels but are at different stages in preparing for climate change based on the number of added measures in their development plans. Regarding physical exposure, Meath and Leitrim, had low physical exposure (0.60 out of a possible 1.00) when considered in comparison to other local authorities in Ireland. This exposure was based on the weighted combined physical exposure as described in Section 5.2.1.7. Regarding preparedness for climate change, Meath and Leitrim were very different. Meath's high number of measures suggests it is better prepared and therefore less exposed, and Leitrim's low number of measures suggests less preparedness and therefore more exposure.

To expand on the second point, Louth and Monaghan (shown in Figure 5.22 with the yellow triangles) each adopted seven measures in their development plans. When it came to physical exposure levels, they were very different. Louth had very low physical exposure (0.54), and Monaghan had very high physical exposure (0.89). While physical exposure and extreme events may galvanize actions, these results show that physical exposure is not significantly associated with the number of measures adopted climate change overall.

Anticipated impacts

Similarly, anticipated impacts have not determined local authorities' preparations for climate change. As Figure 5.23 shows, there was a lack of association between the anticipated impact levels[7] and actions taken by local authorities. Again, local authorities with similar levels of anticipated impacts differed on the number of added measures which were included in the development plans. For example, the three local authorities who anticipated limited impacts each included a different level of added measures: 5, 7 and 9 (as shown in Figure 6.23 with the blue squares).

[7] Within the 2009 survey responses, local authority planners indicated anticipated impact levels (high, limited, or none) for each of six sectors (flooding, water supply, biodiversity, coastal and landslides). Sectors ranked as high impact were assigned a value of 3, limited impact was 2, none was 1, and no answer was 0. The average of the sector values were used for each respondent. This analysis was separate from the weighting for combined exposure as described in Section 3.1.1.7.

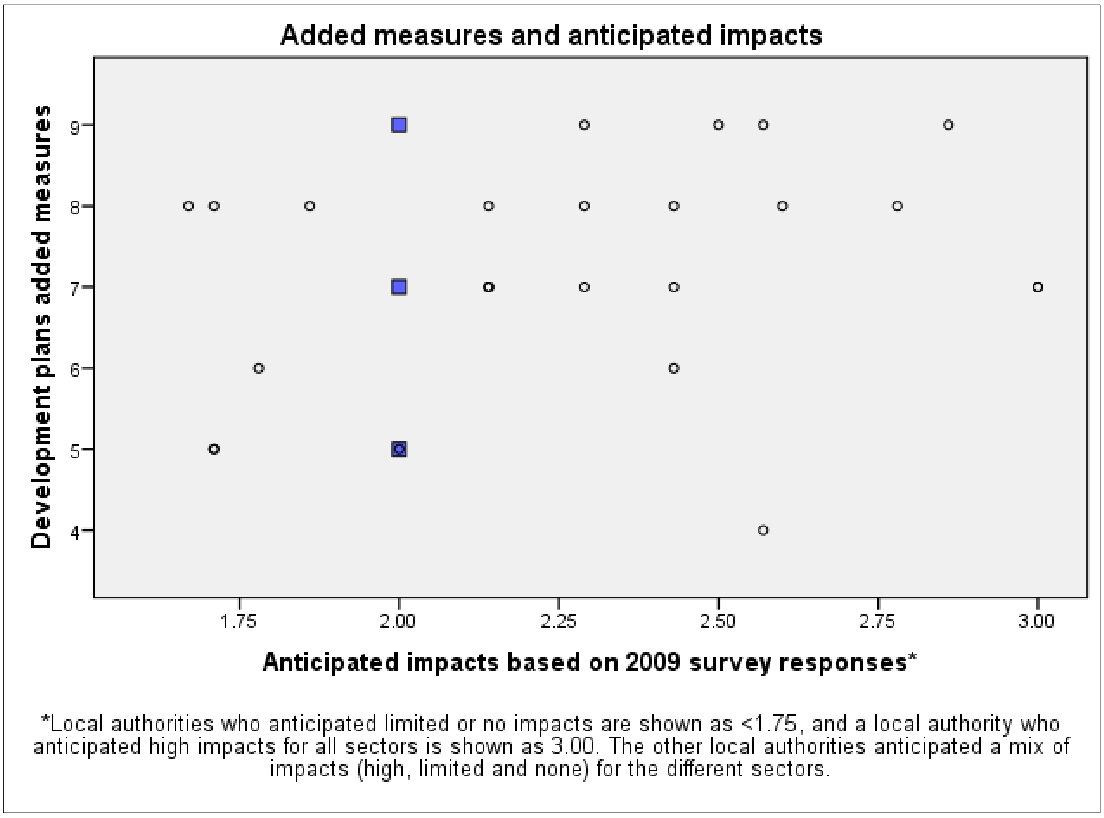


Figure 5.23 Association between added measures and anticipated impacts

The local authorities who included the most measures (9) included some that anticipated the limited impacts and others who anticipated high impacts. Therefore, the level of anticipated impacts was not a significant factor for added measures.

Regional Affiliation

The regional affiliation of local authorities was not a significant factor for increased added measures. As Figure 5.24 shows, the average number of measures for the local authorities in each of the Regions was similar. While Dublin and the Mid-East local authorities were generally more proactive than the local authorities in the West Region, there was no statistically significant difference among the Regions.

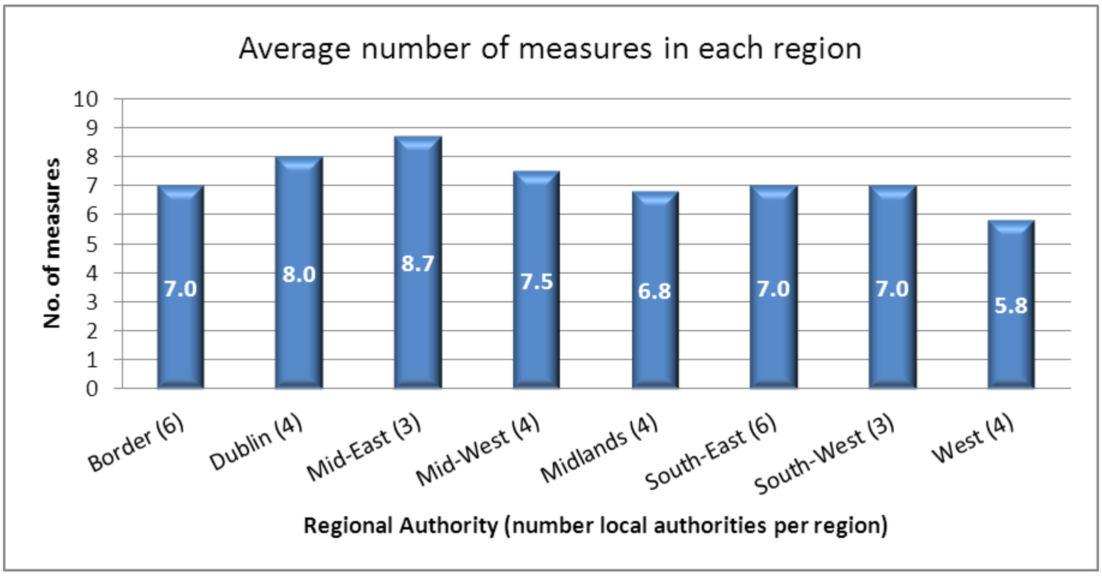


Figure 5.24 Local authority added measures (grouped by regional authority).

Overall, the geographic location and regional affiliation did not significantly affect how proactive the local authorities were. These findings confirm Boyle's (2000) characterisations of the current Regional Authorities as weak institutions with limited power to affect change. This addresses the issue of variations within the Regions and the next section extends this discussion with a focus on more general trends over time. Therefore, some lessons might be learned from further research with regional authorities about potential co-operative efforts.

Date of Development Plans

Current development plans have more added measures than earlier ones, based on a comparison between plans adopted between 2004 and 2010 with more recent ones adopted between 2010 and 2014 as shown in Figure 5.25. This increase was statistically significant when considering plans adopted between 2004 and 2010 ($\tau=0.28$, $p<0.05$), as well as when considering the longer period of 2004 through 2014 ($\tau=0.43$, $p<0.001$).

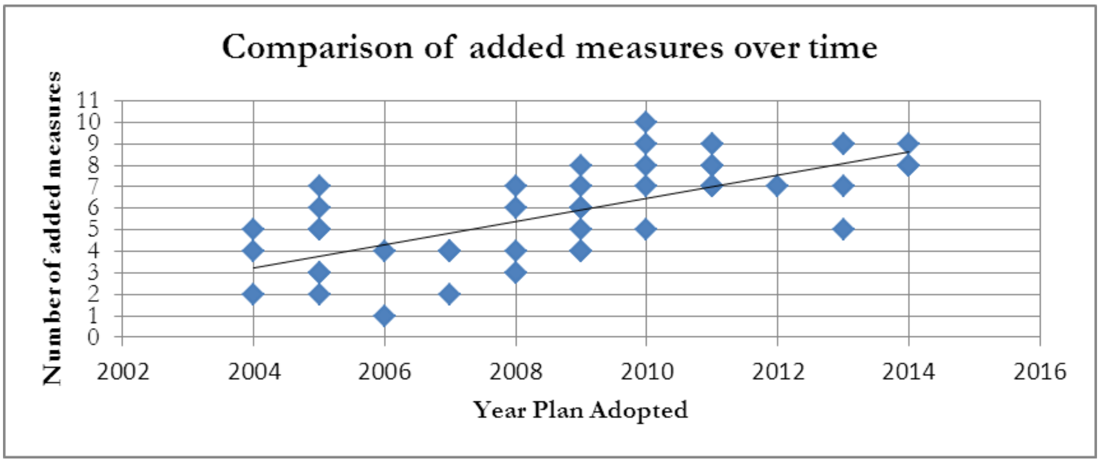


Figure 5.25 Changes in number of development plan added measures over time

This shift suggests that the increased central government direction has prompted local authorities to be more proactive. The increase between 2004 and 2010 was less marked than for the longer period of 2004 to 2014. Prior to 2010, the National Climate Change Strategy 2007-2012 acknowledged the local authorities' role in climate mitigation, but did not require any local actions to address adaptation. More recently, central government has begun incorporating climate change into mainstream policies. For example, the *Planning and Development (Amendment) Act 2010* required development plans to include "measures to reduce anthropogenic greenhouse gas emissions and address the necessity of adaptation to climate change" (Planning and Development (Amendment) Act 2010:13).

Population Density

High population density areas were more likely than rural areas to have more measures within their plans ($\tau = 0.286$, $p<0.05$). Ireland has a highly dispersed population with most of the country having low population density. Overall, the average population density for the cities and counties was 515 people per km^2 (ranging from 20 people per km^2 in Leitrim to 4465 people per km^2 in Dublin City). While the population is not normally distributed throughout the country, examining the distribution of measures shows that the less densely populated areas included some local authorities with very few measures and others with many measures (Figure 5.26). Meanwhile, the more densely populated areas included more measures. Given the small sample set, and taking Dublin City into account, this finding required more investigation to draw further insights.

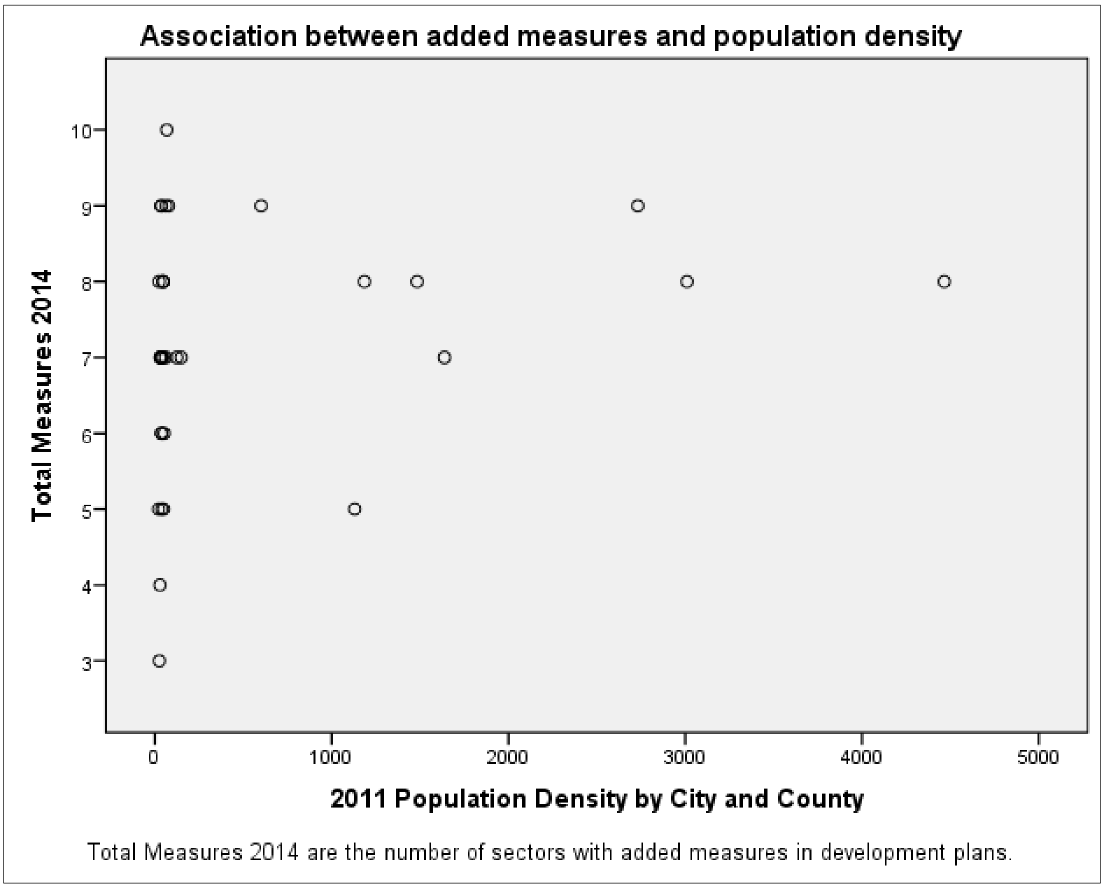


Figure 5.26 Population density and added measures

Overall, mainstreamed climate change measures were not associated with most contributing factors examined. Only population density and development plan dates were positively associated with more measures. The other factors examined showed no significant association with number of added measures (history of exposure, impacts anticipated by 2009 survey respondents, and regional affiliation). This topic was explored through the case studies as to factors that prompt local authorities to adapt.

5.2.3.3. Standalone policies - climate change strategies

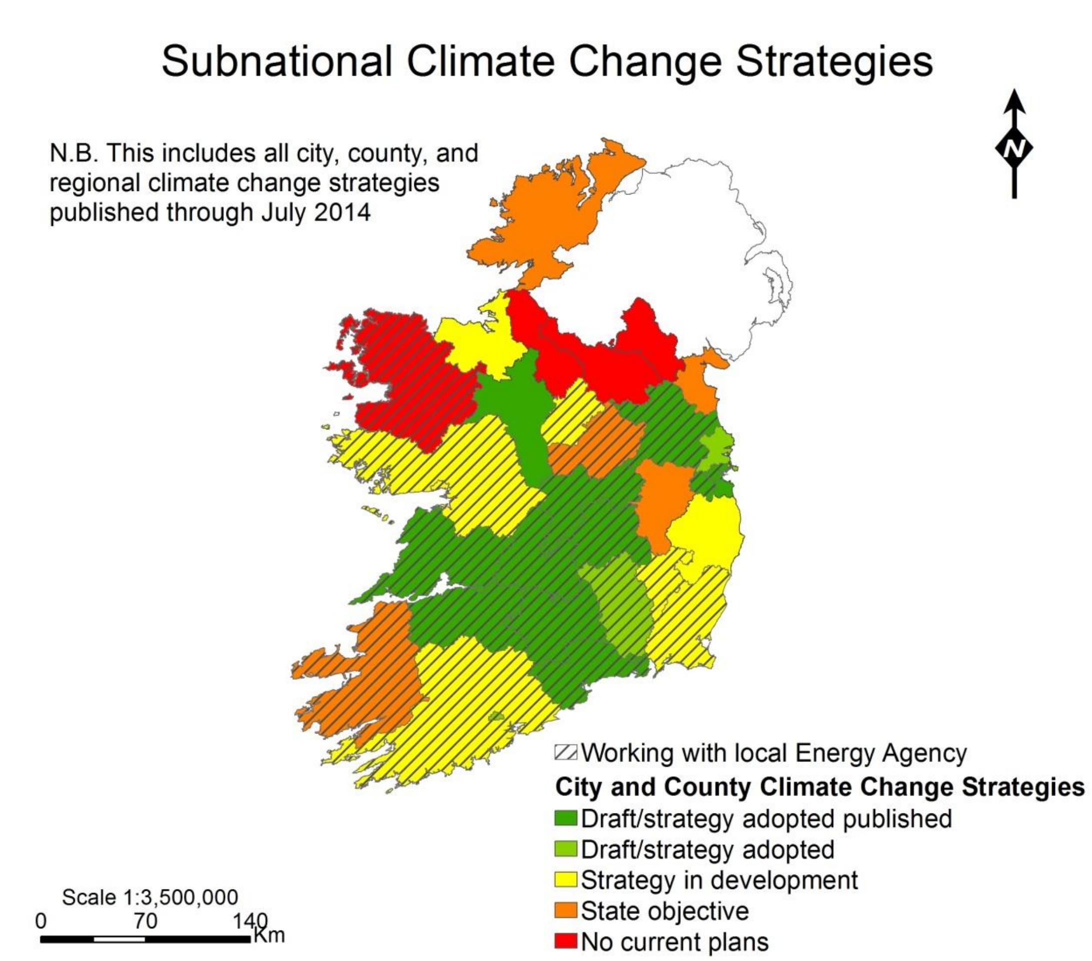
As Table 5.2 and Figure 5.27 show, most Irish local authorities have started the process of addressing climate change through standalone climate change strategies. The main focus is on energy savings and renewable energy without climate change adaptation. These strategies are not standardised in several ways: who developed/adopted the strategy and types of actions included.

Table 5.2 Current status subnational climate change strategies

Exposure	Description of category	Local authorities with this status	
Very high	No current plans to prepare a strategy	Cavan [2] Leitrim [2]	Mayo [2] Monaghan [2]
High	Stated objective to prepare a strategy	Donegal [2] Kerry [2] Kildare [2]	Louth [2] Westmeath [2]
Moderate	Strategy in process	Carlow [3] County Cork [2] Galway City [2] County Galway [3]	Longford [3] Sligo [2] Wexford [2] Wicklow [6]
Low	Completed unpublished strategy	Cork City [2] Fingal [2]	Kilkenny [2]
Very low	Published draft or strategy	Clare [1, 4, 5] Dublin City [1] Dún Laoghaire-Rathdown [2] Laois [1] Limerick City [1, 4, 5] County Limerick [1, 4, 5] Meath [1]	Offaly [1] Roscommon [1] South Dublin [1] Tipperary North [1, 4] Tipperary South [1] Waterford City [1] County Waterford [1]

[1] copy of draft/strategy obtained
[2] based on 2011 survey response
[3] based on details from Association of Energy Agencies in Ireland site (AIEA, 2009).
[4] joint strategy published by Mid-West Regional Authority
[5] joint strategy published by the Limerick Clare Energy Agency
[6] personal communication from County Council 12/2011

Climate change strategies were developed by individual local authorities and regional groupings. The strategies adopted by individual local authorities were developed with help from Energy Agencies. The 14 local agencies in the Association of Irish Energy Agencies (AIEA) are separate entities from the national Sustainable Energy Authority of Ireland (SEAI). These local energy agencies have close relationships with the local authorities – for example, Cork City Energy Agency is housed within the City Hall. According to the AIEA's website 21 local authorities have been "working with their local energy agencies to implement climate change strategies at local level", and Figure 6.28 shows these local authorities by shading (AIEA, 2009).



Subnational climate change strategies details

Date	Jurisdiction	Aims/ Objectives	Specific Actions	Quantified Emissions	Quantified Targets
2010-2012	Clare County Council	X	X	X	X
	Cork City Council	no information available			
2008-2012	Dublin City Council	X	X		
2009 review	Dublin City Council	X	X	X	X
	Dún Laoghaire-Rathdown County Council	no information available			
	Fingal County Council	no information available			
	Kilkenny County Council	no information available			
2009-2012	Laois County Council	X	X		
2006	Limerick Clare Energy Agency[1]	X	X	X	X
2011-2012	Meath County Council	X	X	X	
2008	Mid-West Regional Authority[2]	X	X	X	X
2009-2014	Offaly Local Authorities	X	X		
2011-2013	Roscommon County Council	X	X		
2009	South Dublin County Council	X	X		
2008	South Tipperary County Council	X	X	X	
2011	Waterford City Council	X	X	X	
2008-2012	Waterford County Council	X	X	X	

[1] LCEA Strategy includes Clare, Limerick City, and County Limerick
[2] MWRA Strategy includes Clare, Limerick City, County Limerick, and Tipperary North

Figure 5.27 Sub-national climate change strategies

As is shown in Figure 5.27, working with an Energy Agency does not ensure that a climate change strategy will be adopted. For example, Mayo is working with the Mayo Energy Agency but has no current plans to adopt a climate change strategy.

Conversely, working with an Energy Agency has sometimes resulted in established climate change strategies, as in the case of Clare. On a separate note, the strategies adopted by regional grouping were located in the west of Ireland. The councils for Limerick County, Limerick City, and Clare worked with the Limerick Clare Energy Agency (LCEA) and published a joint strategy in June 2006. This initial strategy was expanded to include North Tipperary County Council in June 2007 with the publication of the Mid-West Energy Balance & Climate Change Strategy.

The details included in climate change strategies varied from just basic to a high level of details. Detailed strategies have been published by Waterford County, Dublin City, and Limerick-Clare and Mid-West regional groupings. The regional climate change strategies by Limerick-Clare and the Mid-West region included county level quantified emissions and CO_2 targets. Similarly, Waterford County Council included sectoral emissions, specific possible actions listed by directorate, a qualitative assessment of CO_2 savings, and practical implementation considerations such as human resources problems, public/political problems, and ease of implementation (Waterford County Council, 2008). Dublin City Council also included sectoral non-quantified targets in its strategy, which was expanded in the follow-up *2009-First Year Review* to include quantified results of indicators (Dublin City Council and Codema, 2008; Dublin City Council, 2009). Conversely, draft climate change strategies without quantified emissions or targets have been adopted by Laois County Council and Offaly County Council.

5.2.3.4. Resources

While available resources constrain adaptation (Adger et al., 2005); this research found that resource levels were not associated, positively or negatively, with adaptation in Ireland. Association for mainstreamed measures and standalone policies were examined, as described below.

As Figure 5.28 shows, forward planning staff numbers were more stable than overall planning staff numbers. Even in cases where there was a reduction in total planning staff, those dedicated to forward planning remained constant or only changed slightly. This was especially true in County Cork, Donegal, Dublin City, Fingal, County Galway, Louth, and Wicklow. This may reflect a reduced need for development planning as the number of planning applications decreased during the recession.

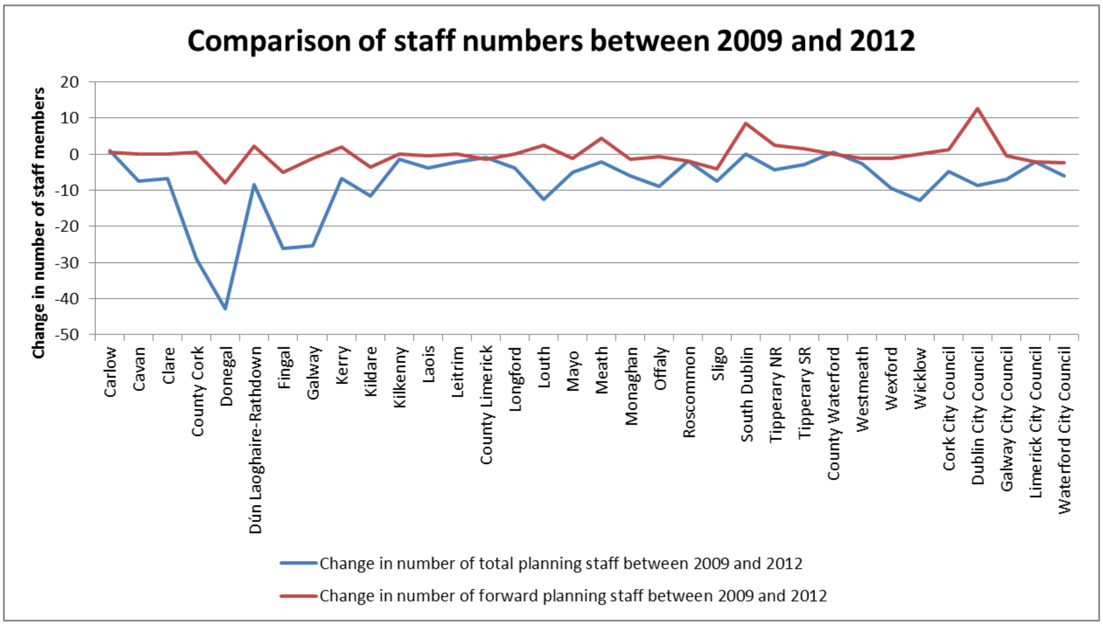


Figure 5.28 Changes in number of staff allocations

However, in looking at the number of total planning staff as shown in Figure 5.29, few of the total planning staff members are dedicated to forward planning. Therefore, this may suggest that the numbers of forward planning staff are already at a minimum level to carry out the functions required under national regulations.

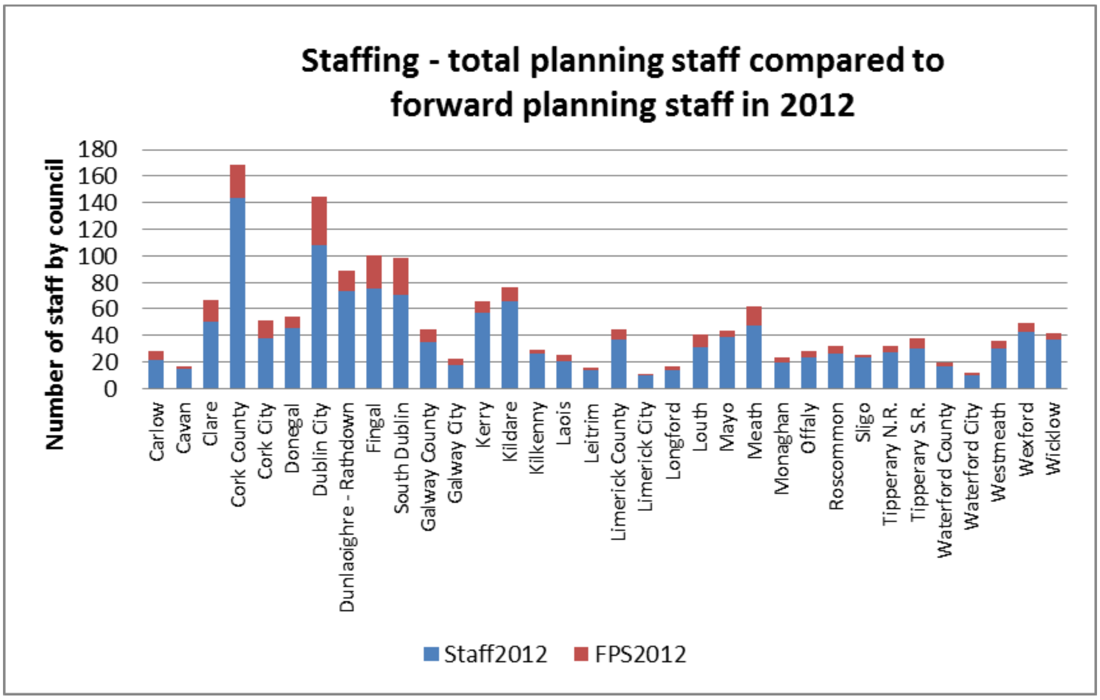
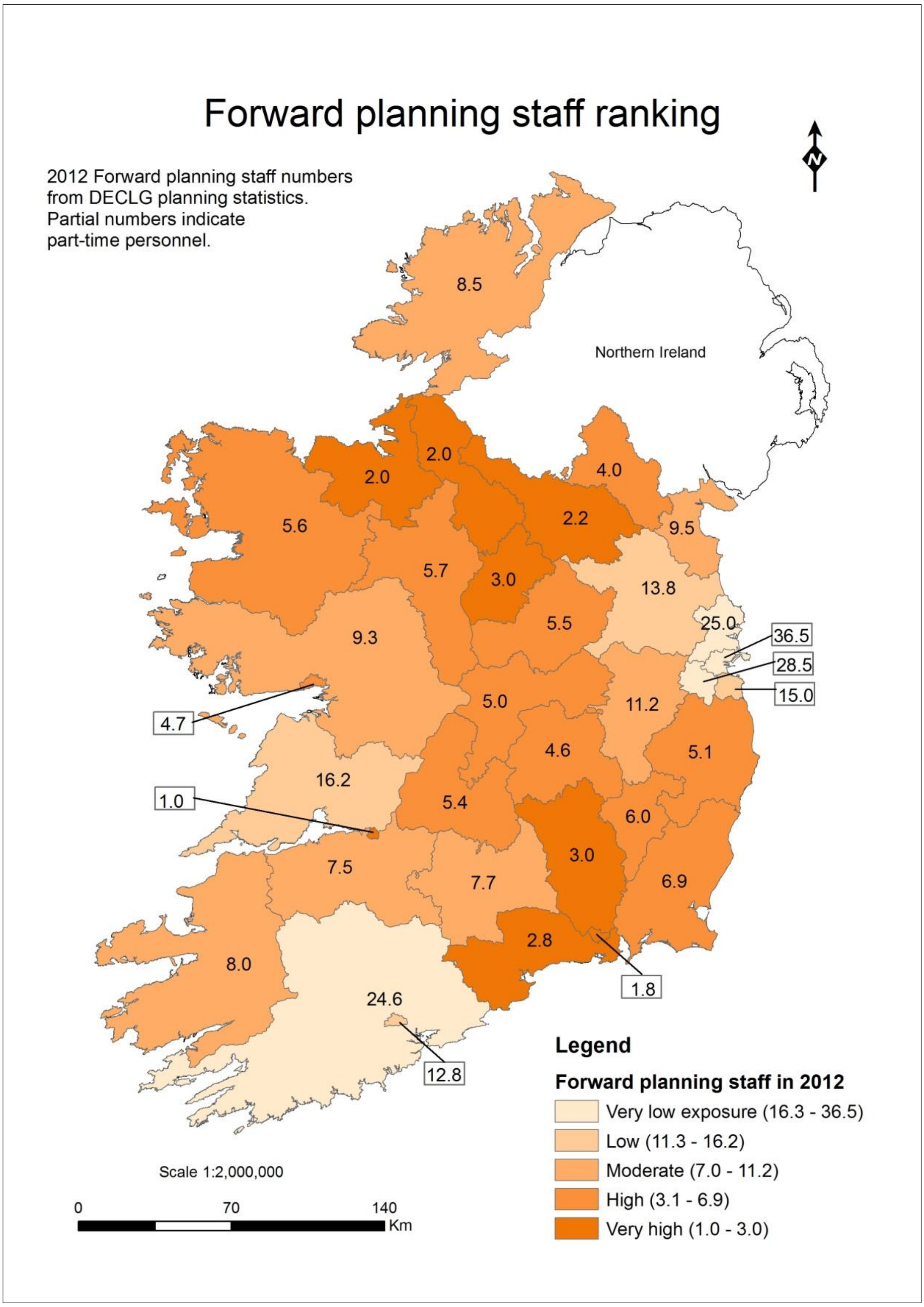


Figure 5.29 2012 staffing numbers

Resource levels vary widely when comparing local authorities in Ireland. Because resources are not provided specifically for climate-related measures, the number of forward planning staff in each local authority was used as a proxy. The number of forward planning staff varied widely per local authority across the nation with an average of 9.1 (range 1 to 36.5), and this distribution is shown in Map 5.9.

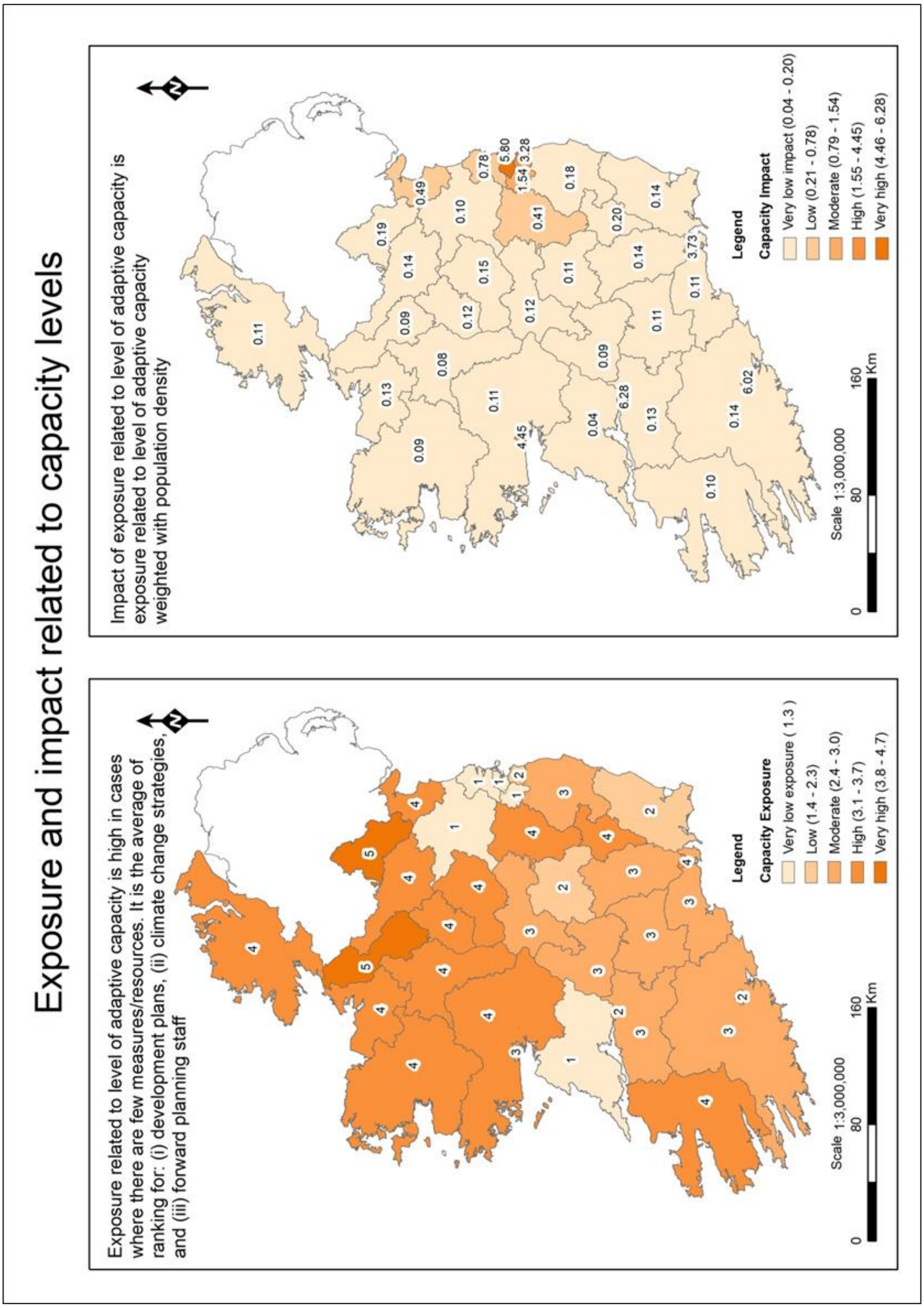


Map 5.9 Local authority forward planning staff numbers

As noted in the *Report of the Local Government Efficiency Review Group,* there is a significant variation in staffing levels (DEHLG, 2010a). As Figure 5.29 showed, councils have allocated different ratios of staff members to forward planning and to development management/enforcement. For example, Dún Laoghaire-Rathdown and Fingal have similar numbers of planning staff (73.5 and 75 respectively), but Fingal has allocated 25 staff members to forward planning as compared to Dún Laoghaire-Rathdown with 15 allocated staff members. Similarly, Offaly (with 23.2 total planning staff and 5 forward planning staff) has allocated more staff members for forward planning than Sligo (with 23.5 total planning staff and 2 forward planning staff).

5.2.3.5. Overall adaptive capacity

Local authorities are in the early stages of preparing for climate change. On the positive side, they have begun adopting climate change strategies, and their development plans are beginning to include measures to address climate change. On the negative side, few staff members are allocated to forward planning duties. The local authorities who are less prepared for climate impacts will face greater challenges to adapt. Based on publicly available information, local authorities are least prepared for climate change in Leitrim and Monaghan as shown on Map 5.10a. Conversely, a few local authorities have prepared more fully for climate change: Clare, Dublin City, Fingal, South Dublin, and Meath. Overall, local authorities in the Southeast and East tend to be more prepared than those in the West and Northwest of the Country. When considering population (Map 5.10b), there is very high impact related to adaptive capacity in the cities of Dublin and Cork.



Map 5.10a Exposure and 5.10b Impact related to adaptive capacity levels

Based on the foregoing results, the driving forces to advance climate change measures are not easily defined or assessed. Given the foregoing, less prepared local authorities will not be saved by quick fix measures such as added staff alone. Answering the question about what does bring forth actions requires further information.

5.2.4. Climate change vulnerability

Bringing together the exposures for physical climate-related sectors and adaptive capacity facilitates some insights about climate change vulnerability. As Table 5.3 below shows, climate vulnerability is the relation between physical climate exposure and adaptive capacity. The greatest vulnerability occurs where both criteria are at their highest levels.

Table 5.3 Conceptual climate vulnerability matrix

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Physical climate exposure</td></tr>
<tr><td>Limited exposures</td><td>Some exposures</td><td>High exposures</td></tr>
<tr><td rowspan="3">Exposure related to level of adaptive capacity</td><td>Few actions</td><td></td><td></td><td></td></tr>
<tr><td>Some actions</td><td></td><td></td><td></td></tr>
<tr><td>Many actions</td><td></td><td></td><td></td></tr>
</table>

Matrix adapted from Aall and Norland (2005)

Within the Irish context, each city and county council's climate vulnerability was calculated. The specific results for each city and county (hereafter referred to as 'local authorities') are presented in Table 5.4 and Figure 5.30 with climate exposure shown in section (a) on the left and climate impact shown in section (b) on the right. On the vertical axis of section (a) in both the graph and table, local authorities at the top have taken few steps to plan for climate change, and therefore have high exposure on the adaptive capacity axis. Conversely, local authorities at the bottom have taken more actions and have lower exposure on the adaptive capacity axis.

The horizontal axis of section (a) of Table 5.4 and in section (a) of Figure 5.30 shows physical climate exposure, which is the combination of the previously discussed flooding, landslides, water supply, coastal erosion, sea level rise, and biodiversity. Local authorities towards the left on the horizontal axis have relatively less exposure when compared to other local authorities. Conversely, local authorities on the right of the horizontal axis have relatively greater exposure when compared to other councils. Combining the two axes (the actions on the vertical axis and the physical processes on the horizontal axis) illustrates each council's relative vulnerability. For example, Leitrim (LM) has taken few actions (high exposure related to adaptive capacity) but has very low physical exposures. Therefore, they may have less to deal with regarding climate change, yet they may be unprepared to deal with events and conditions that do occur.

In the same Table 5.4 and Figure 5.30, section (b) focuses on the impacts and the number of people likely to be affected. The exposure scores illustrated on the left (and summarised in Appendix B) are multiplied by the population density in each local authority area. Therefore, the impact of a local authority's exposure related to adaptive capacity is reduced when there is a low population, as in the case of Leitrim. Similarly, the impact of a local authority's physical exposure is reduced when there is a low population. Because Leitrim has the lowest exposure (in relation to other local authorities), it is still at the lowest end of the range. However, in local authorities with greater population density, such as Dublin City (D), their low exposures in section (a) contrast with higher impacts in section (b) because of the greater number of people likely to be affected.

The complexity of climate change vulnerability presents a challenge in communicating relevant information to local authority staff members. This is further complicated because most vulnerability information has been prepared at national scale rather than at local authority scale. As part of the communication of climate vulnerability, a one-page overview for the case study local authorities was prepared. County Mayo is included in this chapter (Figure 5.31), and the remaining 3 case studies are included in Appendix F. This overview shows both the city/county ranking as well as the national average, which provides a holistic assessment of areas that are likely to require additional attention.

Table 5.4 Climate vulnerability matrix

Climate Vulnerability

Climate exposures on the left in section (a) represent the likely climate effects that need to be addressed.
Climate impacts on the right in section (b) represent the number of people likely to be impacted by these exposures.

(a) Physical climate exposure

Exposure related to level of adaptive capacity	Very Low	Low	Moderate	High	Very High
Very High	LM				MN
High	LH	KE W WH	CN DL LD	G+ KY MO RN SO	
Moderate	TN WW	LK OY WD	KK	CW C+ G*	TS
Low	WX	L	LS	C* DLR	
Very Low	CE MH			D F SD	

(b) Impact of physical climate exposure (exposure weighted with population density)

Impact of exposure related to level of adaptive capacity	Very Low	Low	Moderate	High	Very high
Very High				L	C* D
High			W	DLR G*	
Moderate			SD		
Low		KE LH	F		
Very Low	CW CN CE C+ DL G+ KY KK LS LM LK LD MO MH MN OY RN SO TN TS WD WH WX WW				

County Abbreviations

Carlow (CW)	Donegal (DL)	Co. Galway (G+)	Leitrim (LM)	Mayo (MO)	Roscommon (RN)	Co. Waterford (WD)
Cavan (CN)	Dublin City (D)	Kerry (KY)	Limerick City (L)	Meath (MH)	Sligo (SO)	Westmeath (WH)
Clare (CE)	Dún Laoghaire-Rathdown (DLR)	Kildare (KE)	Co. Limerick (LK)	Monaghan (MN)	South Dublin (SD)	Wexford (WX)
Cork City (C*)	Fingal (F)	Kilkenny (KK)	Longford (LD)	North Tipperary (TN)	South Tipperary (TS)	Wicklow (WW)
Co. Cork (C+)	Galway City (G*)	Laois (LS)	Louth (LH)	Offaly (OY)	Waterford City (W)	

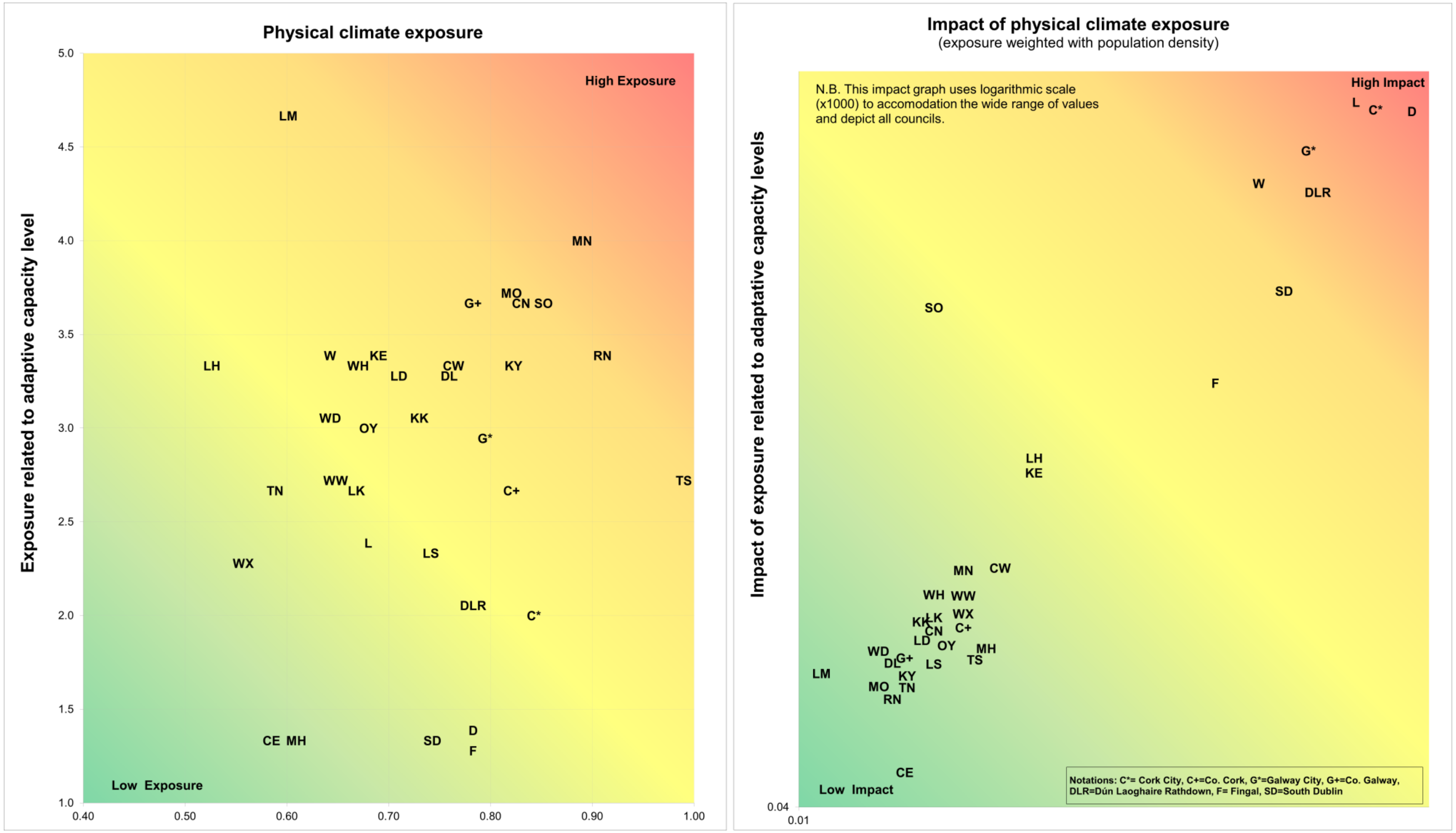
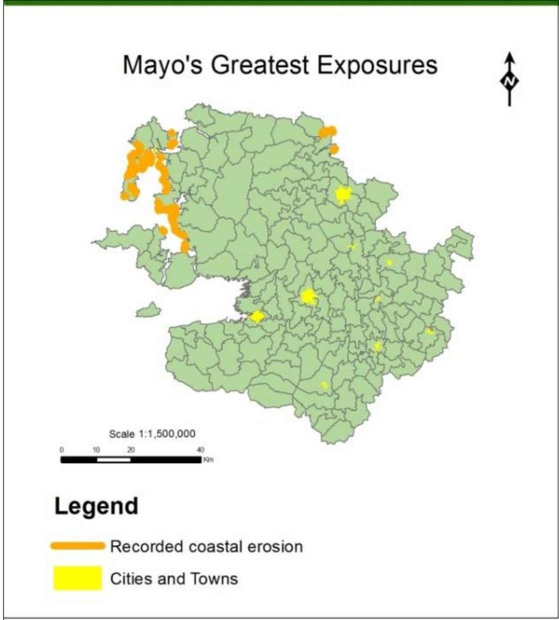


Figure 5.30 Climate vulnerability graph with exposure (left) and impact (right)

Mayo

Greatest Exposure:

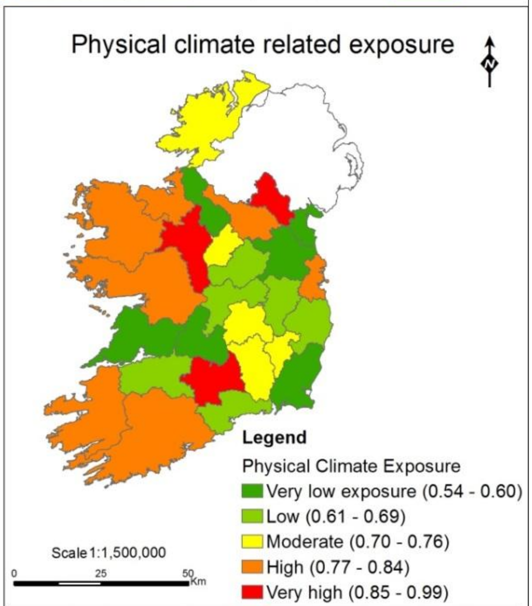
- Sea level rise
- Coastal erosion



Sector Exposures:	Mayo	Ireland
Floods * Flood events * Precipitation 2031-2060	3.0	2.9
Landslides * Recorded events * > 15° slope (% area) * Peatlands (% area)	3.7	2.2
Water Supply * Public water supply at risk * Precipitation 2031-2060	3.5	2.9
Coastal Erosion * Coast at risk * Erosion trends	4.5	2.7
Sea Level Rise * Elevation less than 1 metre * Storm surge * Aquifers	3.7	3.1
Biodiversity * Protected sites (% area) * Protected species	1.5	3.2
Adaptive Capacity * Added measures in plan * Climate change strategy * Forward planning staff	3.7	2.8

	Classes				
Exposures	Very low	Low	Moderate	High	Very High
Floods	1.5 - 2.0	2.1 - 2.5	2.6 - 3.0	3.1 - 3.5	3.6 - 4.5
Landslides	1.0 - 1.3	1.4 - 2.0	2.1 - 2.7	2.8 - 3.7	3.8 - 4.3
Water supply	1.0	1.1 - 2.0	2.1 - 2.5	2.6 - 3.5	3.6 - 4.5
Coastal erosion	1.0	1.1 - 1.5	1.6 - 2.5	2.6 - 3.5	3.6 - 4.5
Sea level rise	1.7 - 2.0	2.1 - 2.3	2.4 - 2.7	2.8 - 3.7	3.8 - 4.3
Biodiversity	1.0	1.1 - 2.0	2.1 - 3.0	3.1 - 4.0	4.1 - 5.0
Adaptive capacity	1.3	1.4 - 2.3	2.4 - 3.0	3.1 - 3.7	3.8 - 4.7

*For example, floods sub-index value is the average of (Flood events and Projected precipitation)



Sectoral weighting based on 2009 survey of local authorities	Floods	Water	Biodiversity	Coast	Landslides
Coastal counties	24.3%	18.6%	20.7%	23.6%	12.9%
Inland counties	30.3%	33.3%	27.3%	n/a	9.1%

Figure 5.31 Summary sheet for County Mayo

5.3. Discussion

In assessing how climate change will affect Irish local authorities, this research focuses on their service provision for areas such as flood risk management as well as the challenges in meeting higher level requirements for new policies and practices. The assessment has limitations because of the narrow definition of vulnerability and because of the blurred lines of responsibilities as discussed below. The assessment provides a starting point to consider the implications of climate change and should not be considered as a basis for planning specific adaptation measures.

Assessing how climate change will affect local authorities in Ireland is a narrow subset of vulnerability which narrows conclusions which can be drawn. The vulnerability of local authorities in relation to their service provisions and policies was included; the vulnerability of individuals residing within the jurisdictions was excluded. A full assessment of an area's vulnerability encompasses physical and human conditions. The physical conditions include the existing state, the sensitivity of the individual components to change, and future states under climate change - all tempered by the interactions with the social systems. The human conditions include the capacity of the individuals and groups to react which is affected by their knowledge of potential harm, the external large scale processes that affect the individuals and groups in the study area, and the uncertainty related to whether the individuals will choose to take responsibility where they can or defer responsibility to others such as governments. These considerations are part of an iterative process where vulnerability evolves over time.

The lines of responsibility are blurred because responsibility is shared among local authorities, central government and private individuals. For example, responsibility for flood risk management is shared. Local authorities are the first responders to flood events and spatial planning is within their remit. Their adaptive capacity is limited by their reliance on central government for funding, extended flood risk assessments, and statutory backing to enforce actions by private individuals. Individuals have responsibility for their decisions and their property.

5.4. Conclusion

The foregoing assessment provided holistic information about climate-related challenges the local authorities are likely to face, considered within a national context. This assessment suggests that there are limited government actions to address how Ireland will be affected by climate change. The climate change vulnerability assessment confirmed sub-national variations and potential for increasing attention to climate change. Sub-national variations were present for the indicators such as recorded flood events, for the sectors such as flooding exposure, for adaptive capacity such as added measures in development plans, and for impacts to overall physical climate change.

Current local authority measures are more aspirational than realised. On the positive side, mainstreamed climate change measures in development plans have increased between 2004 and 2014, and climate change strategies have been adopted since 2008. On the negative side, local authorities are in the early stages of adapting to climate change. This is evidenced by objectives rather than concrete measures in development plans and climate change strategies as well as by the lack of dedicated resources for climate change.

Even with the foregoing limitations, this climate change vulnerability assessment is the first nationwide assessment to consider both the physical and adaptive capacity components. The information extends the knowledge about the challenges local authorities will face with climate change and their capacity to adapt. However, the assessment provided limited information about what prompts local actions. The different contributing factors provided a starting a point for further research. Proactive plans were more likely in recent times and in highly populated areas. At the same time, impacts were not associated with more proactive plans or strategies.

These Chapters 4 and 5 reported the results from the first research strand which addressed Research Aim 1 (assess the ways that climate change will affect Ireland). Chapter 4 identified good practice examples and adaptation deficits by Irish local authorities through the Development Plan Review (Objective 2). Chapter 5 identified the local authorities which face greater challenges associated with climate change than other local authorities in Ireland (Objective 1). The foregoing provided a starting point for the second research strand as reported in the remaining Results Chapters 6 and 7.

Chapter 6. Surveys

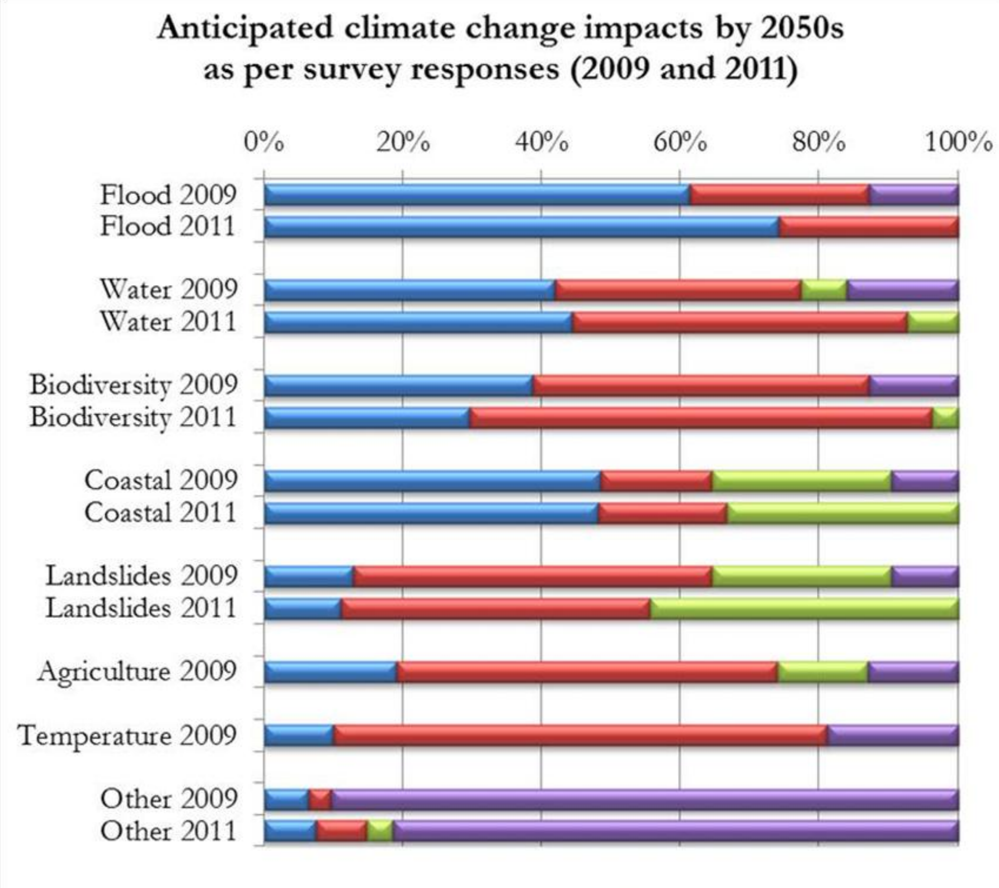
Building on the climate change vulnerability assessment reported from the first research strand in Chapters 4 and 5, this chapter shifts the focus to the second research strand and reports further results from the two national surveys in 2009 and 2011. Chapter 4 identified existing actions by local authorities, and Chapter 5 assessed the ways that climate change will affect Irish local authorities (Aim 1). Chapters 6 and 7 present the results about the factors that affect adaptation by local authorities (Aim 2). Chapter 6 presents the survey results, and Chapter 7 presents the case study and interview results.

The surveys collected input from local authority planners in 2009 and 2011 (with 91% and 79% response rates, respectively). Detailed information about the survey design, participants, and logistic details were described in Section 3.2.1, and copies of the surveys are included in Appendix E. These results focus on three key themes: anticipated impacts, local policies and actions, and factors affecting local authority adaptation.

6.1. Anticipated impacts

Irish local authorities anticipated climate-related impacts in their area across different sectors (flooding, water supply, biodiversity, coasts and landslides). The responses differed in two ways: by respondent and by sectors. Most respondents differentiated between the sectors, except for three respondents. Two ranked all sectors as high impact, and one ranked all sectors as limited impact. In two cases, respondents wrote in detailed responses that showed how uncertainty plays a role in local authority responses. Respondent 30 stated: "really, the extent of this is unknown – we know that there will be some level of impact, but it is unknown if this will be a high or limited impact." Respondent 19 was "not sure what would be considered a high impact and what a limited impact" and included detailed projections from the *Climate Change, Heritage and Tourism: Implications for Ireland's Coast and Inland Waterways* publication by Heritage Council and Fáilte Ireland (Kelly and Stack, 2009).

Most local authorities anticipated climate-related impacts as shown in Figure 6.1. Flooding was listed most commonly for high impacts, and water supply and biodiversity were ranked as high or limited impacts by most local authorities. The coastal sector was mixed because coastal authorities anticipated high impacts, and inland authorities did not anticipate any impacts. Lastly, a few local authorities listed other impacts which included extreme events, pluvial flooding, damage to road/wastewater and storm water and wastewater infrastructure, and tourism and building design.



	High	Limited	None	No Answer
Flood 2009	61%	26%	0%	13%
Flood 2011	74%	26%	0%	0%
Water 2009	42%	35%	6%	16%
Water 2011	44%	48%	7%	0%
Biodiversity 2009	39%	48%	0%	13%
Biodiversity 2011	30%	67%	4%	0%
Coastal 2009	48%	16%	26%	10%
Coastal 2011	48%	19%	33%	0%
Landslides 2009	13%	52%	26%	10%
Landslides 2011	11%	44%	44%	0%
Other 2009	6%	3%	0%	90%
Other 2011	7%	7%	4%	81%

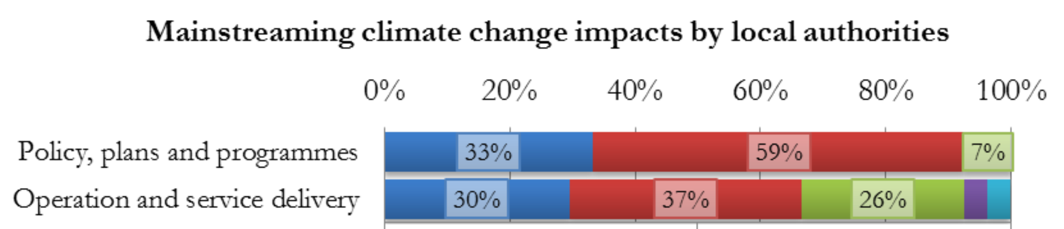
Figure 6.1 Anticipated impacts as per survey responses (2009 and 2011)

6.2. Local policies and actions

Most local authorities reported some climate measures in the form of local policies and specific actions. The local policies include mainstreamed climate impacts and varied by extent and sectors addressed. The specific actions include risk assessments and good practice examples. have started acting on climate change with their local policies and specific actions. The local policies and actions included mainstreamed climate change measures, Most local authorities have mainstreamed climate change impacts to some degree, with some sectors more prevalent than others.

6.2.1. Mainstreamed climate impacts

Most local authorities have incorporated climate change into their policies and operations ("mainstreaming") as shown in Figure 6.2. One-third of local authorities reported mainstreaming "to a considerable extent" for both policies and operations. Further, mainstreaming "to some extent" was reported for policies (59%) and operations (37%). Few operational changes were reported by 26% of local authorities; who indicated mainstreaming "to a small extent". Overall, local authorities indicated greater mainstreaming for policies than for operations.



	Operation and service delivery	Policy, plans and programmes
To a considerable extent	30%	33%
To some extent	37%	59%
To a small extent	26%	7%
Not considered at all	4%	0%
No answer	4%	0%

Figure 6.2 Comparison of mainstreaming in policies and operations.

This mainstreaming addressed few sectors according to survey respondents, most of whom listed 3 or fewer sectors [4 impacts (5 respondents), 3 (14), 2 (7), 1 impact (4 respondents)]. These mainstreamed impacts varied with some sectors more prevalent, such as flooding, than others as shown in Figure 6.3. These sectors were derived from the analysis of the survey responses rather than specific pre-defined sectors. The six sectors that emerged in the analysis were flooding, energy/emissions, biodiversity, water supply, coastal, and others. The detailed examples are discussed by sector as follows.

Flooding

Within the reported sectors, flooding was the most commonly addressed climate impact (see Figure 6.3). These measures varied widely even when considering them in the context of aggregated categories listed in Figure 7.3. The specific types of flooding measures included: Sustainable Urban Drainage Systems (SUDS) (listed by 7 respondents), flood risk assessments (7), OPW and national guidelines on flood risk management (8), limit development in areas at risk of flooding (7), general statement referencing development plan (5), EU Directives (2), flood risk linked with water treatment and biodiversity (1), and flooding indicated without specifics (1). Overall, respondents referenced best practice guidelines (SUDS and national guidelines), flood risk assessments, and limited development in flood prone areas. Unfortunately, the responses did not include specific ways that flooding would be affected by climate change. There was one exception – one respondent linked flood risk with water treatment and biodiversity.

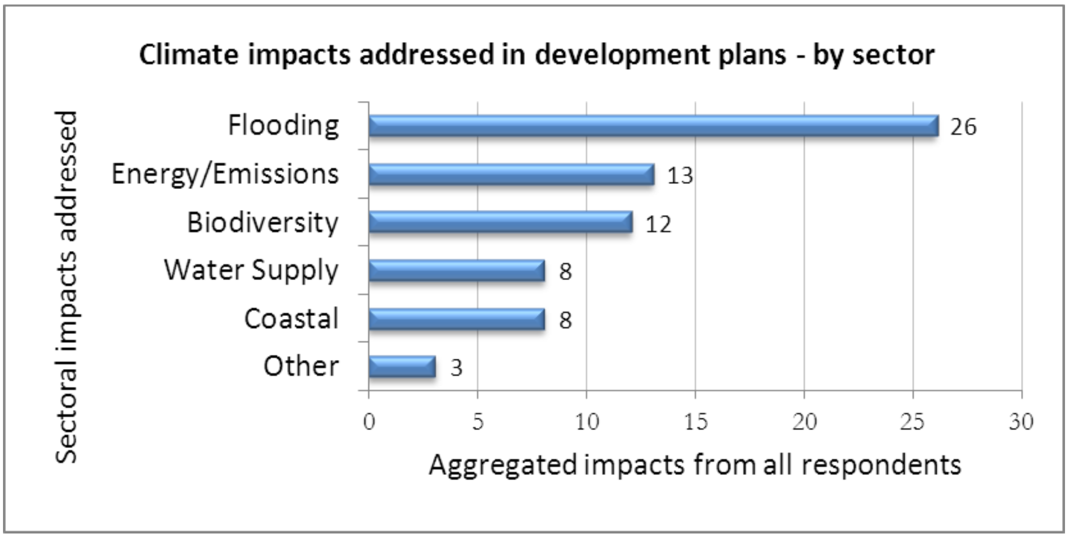


Figure 6.3 Climate impacts addressed in development plans – by sector

Energy and emissions

Energy and emissions were noted by 13 respondents with references to transport (8), energy – demand reduction/efficiency (6), and energy – renewables (9). One respondent merely noted that a policy was contained within the development plan. These responses show that mitigation features highly in the minds of planners.

Biodiversity

Biodiversity was listed as an impact by 12 respondents, with references to local actions, higher level requirements, and invasive species. Local actions included biodiversity action plans (6), strategic environmental assessments (2), and dedicated staff (2). Higher level requirements included EU directives (3) and designated sites/species (5). Two local authorities acknowledged potential impacts from alien species without a direct link to climate change. Only one local authority listed biodiversity as an impact without indicating how it was addressed in the development plan.

Water supply

Water supply was listed by 9 respondents, with most focusing on quantity (6), some on quality (3), conservation (1), and one unspecified. The quantity of water supply was being addressed through upgrades in infrastructure in conjunction with national government and/or River Basin Districts. Respondent 8 noted that "longer term requirements [are] being addressed on a regional basis", which foreshadowed the nationalisation of water supply. Interestingly, only two respondents noted a need for water conservation: one recommended water pricing and the other focused more broadly on infrastructure investment with a token acknowledgement of the need for water conservation needs assessment. Two respondents referenced their development plans without providing details.

Coastal impacts

Coastal impacts were listed by 8 respondents for coastal erosion (6) and sea level rise (4). As noted earlier, one survey respondent linked biodiversity with coastal issues – this respondent also addressed coastal impacts separately. More generally, the respondents cited new and ongoing policies for coastal impacts. New policies were referenced by 4 respondents for coastal zone management and marine, a new coastal defence strategy, and "consideration of increased finish floor levels for developments within the city and Docklands which are likely to be at risk". Ongoing measures were referenced by 3 respondents for strengthening existing coastal defences/setback lines, and ongoing maintenance works. One local authority noted concerns regarding coastal erosion and landslides. Another local authority referenced its development plan without providing details.

Other impacts

Other impacts cited by 11 respondents ranged from specific matters such as agriculture and landslides to an overall strategic focus. Most of the specific matters listed provided very limited information without specific measures or clear links with climate change. Two exceptions related to landslides and higher temperatures. The landslide impact was addressed through "geotechnical stability assessments [being] required for wind farm development proposals in upland areas" (respondent 28). For higher temperatures, the local authority "facilitates the implementation of water conservation projects, which amongst others aim to reduce leakage in existing distribution systems".

The statements of overall strategic focus were interesting because some were very preliminary and others suggested a transformational change. Three responses included preliminary comments for proposed strategies, input from the public and generic links with SEA and sustainable development. First, one respondent noted that the council had a policy to prepare a climate change strategy. Second, another respondent noted that: "In our most recent issues document – seeking submissions from interested parties [as part of the consultation process of development plan preparation], there is one paragraph mentioning Climate Change. The issue will therefore feature in the eventual plan. It is probable that the Environment SPC [Strategic Policy Committee] will address climate change in the course of it's [sic] work". The third preliminary measure was where one respondent placed climate change under the umbrella of SEA and sustainable development: "Although specific examples are given above, planning for climate change will be screened and scoped in the SEA. It is a key consideration in delivering a sustainable development plan and will be addressed in conjunction with all spatial planning concerns re: housing, economic growth, etc."

Transformational changes were suggested by three respondents who framed climate change as a driving force rather than something to be responded to. Climate change was noted by one respondent as "one of the key drivers of change within our community". Another noted that "climate change will be one of the four cross-cutting themes underpinning the new development plan". The third respondent viewed climate change as a cross-cutting theme:

> Overall development of [the] county has potential to influence climate change. This matter is addressed in the SEA for the County Development Plan and as a result of the SEA process mitigation measures, i.e. approach to policies and objectives are designed to reduce impact on climate as a result of development. As climate change is a very complex matter, it is not possible to provide one policy or approach to deal with it, rather the vision for future development must be influenced by proactive measures towards sustainability.

Even considering all of the foregoing links with climate change, the perceptions by local authorities suggest that mainstreaming needs to be increased into local authority plans.

6.2.2. Actions – risk assessments

Local authorities have also taken action to address climate change through risk assessments and good practice examples. Most local authorities (65%) reported that they had undertaken some risk assessments that had relevance to climate change. While there were no specific climate change assessments, other risk assessments also address climate change to some extent, e.g. strategic environmental assessment and flood risk assessments as shown in Figure 6.4.

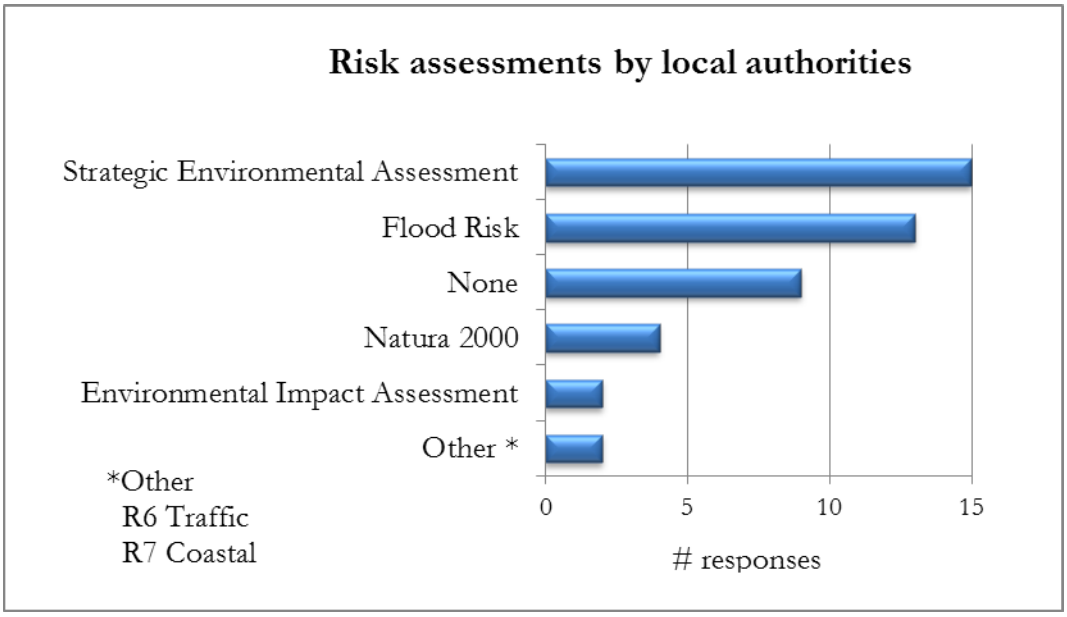


Figure 6.4 Risk assessments by local authorities

These synergies were confirmed by Respondent 28:

> Flood Risk Assessments, Environmental Impact Statements and Strategic Environmental Assessment deal with potential effects on [sic] climate change. However, there is no specific tailored assessment carried out purely for climate change. However, the issues of climate change would sit within the mentioned forms of impact assessment.

These other assessments are driven by higher level regulations such as EU Directives with a resulting increased level of risk assessments by local authorities. For example, risk assessments were much more prevalent in Ireland than in Australia where only 12% of local authorities had carried out risk assessments (Local Government and Shires Association New South Wales, 2006). This has direct relevance to higher level requirements because in 2006 Australian local authorities were not required to carry out risk assessments for climate change. More recently, the New South Wales state government is requiring local governments to consider future climate change in their planning practices (Gero et al., 2012).

While Irish risk assessments were prevalent, the survey responses show that one-third of Irish local authorities have not undertaken risk assessments related to climate change. While most survey respondents did not give any comment, Respondent 31 commented as follows::

> NONE [risk assessments] – Local authorities work under the remit of the P&D Act 2000. This outlines what local authority planning sections are required to do. Given staffing resources it is very difficult for planning authorities to go beyond statutory requirements.

This response suggests that local authorities were not required to undertake climate-related risk assessments, and that they did not have capacity to go beyond minimum requirements. This experience is contrary to the other local authorities who listed the other related risk assessments that they had undertaken. Therefore, the results about risk assessments were mixed. While there were no dedicated climate change assessments by local authorities, two-thirds of local authorities had carried out other risk assessments that also addressed climate change to some degree. Further information would be needed about the extent of those risk assessments to draw conclusions about how well future risks had been assessed.

6.2.3. Actions - Good practice examples

In addition to mainstreamed provisions and risk assessments, good practice examples were provided by most survey respondents (see Figure 6.5). In the survey there was no guidance as to what would constitute "examples of best climate adaptation practice" (Question 9 in 2009 Survey – Appendix E). Even so, one-third of respondents listed no good practice examples.

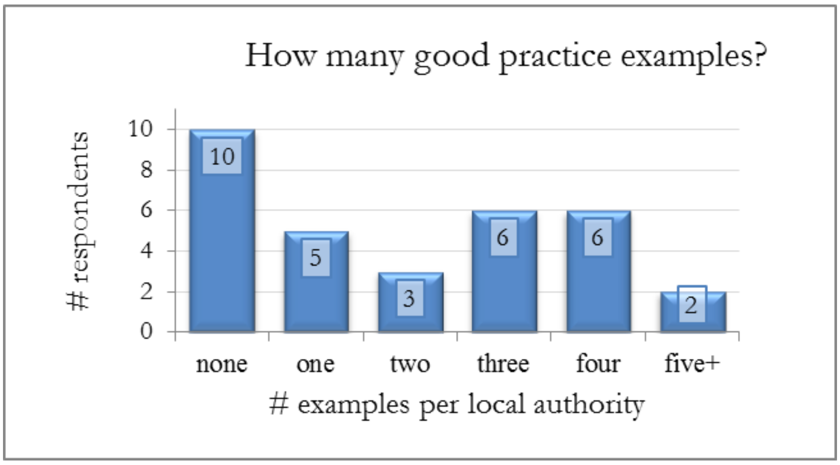


Figure 6.5 Number of good practice examples cited by survey respondents

Sectors addressed

The responses showed that some sectors were more commonly addressed, such as flooding, than others as shown in Figure 6.6.

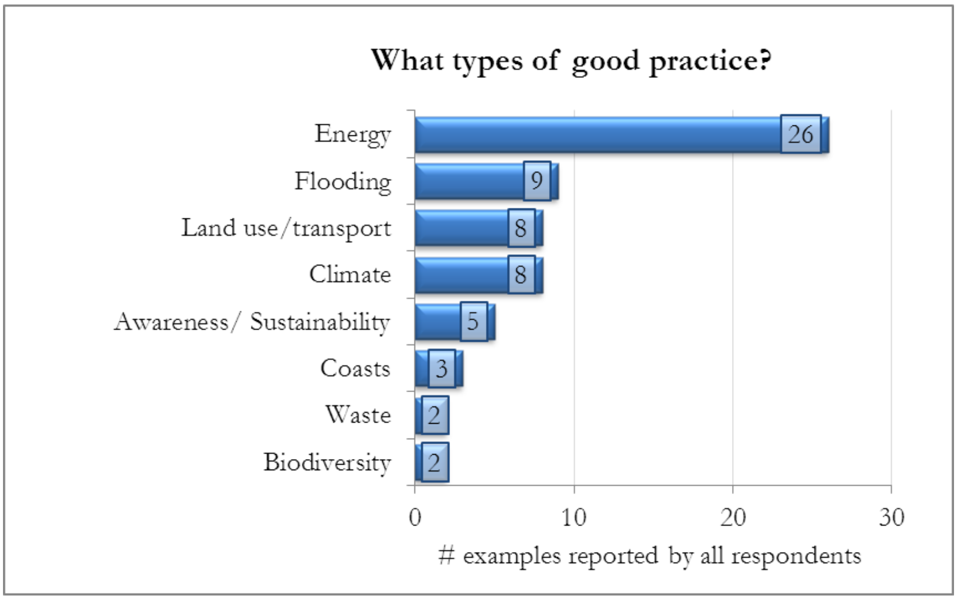


Figure 6.6 Good practice examples grouped by sector

These good practice examples were sorted into sectors as part of the analysis rather than pre-determined sectors or a narrow range of actions described by the local authorities. Drawing together the most similar examples resulted in six groupings: energy, flooding, other, climate, awareness/sustainability, land use, transport, coastal, and biodiversity.

Twenty-six best practice examples for energy were noted by 13 respondents. The best practice examples for energy included working with Energy Agencies (3), established energy policies/strategies/plans (8), demonstration projects (7), and generalised statements about energy use and renewable energy (9). The examples of working with energy agencies were listed without specifics except in one case where a joint venture between the local authority, the energy agency and FÁS (the Irish National Training and Employment Authority) established a training programme for local authority staff members regarding renewable energy and energy efficiency. The established energy policies included an internal energy policy, a sustainable energy action plan, a green roofs policy, 3 wind energy strategies/policies, 1 local authority with requirements for energy efficiency requirements in local area plans, and 2 local authorities with more stringent energy rating requirements (Building Energy Ratings) than are required by national standards. The demonstration projects included:

- 1 local authority supported electric charging vehicles infrastructure,
- 1 local authority used renewable energy sources for the area office and county hall, and
- 1 local authority reported 6 demonstration projects using different types of renewable energy: solar, combined heat and power, biomass, biogas, a building management system, and plans for public lighting retrofits.

The generalised statements related to energy use and renewable energy. One local authority linked improved spatial planning and energy use planning. Three local authorities included generic examples to promote, encourage and facilitate the use of renewable energy.

Flooding examples were noted by 9 respondents for infrastructure (2), studies (2), policies (4), and a detailed listing about the need for catchment management. The infrastructure examples were a flood barrier by one local authority and 3 strategic drainage ponds by another local authority. The studies were a flood relief study in one local area and a flood impact analysis in another. The policies were listed by 4 local authorities for flood risk management, sustainable urban drainage systems, integrated sustainable approach, and specified height above datum with reference to flooding potential. Each policy was listed briefly without further description. Lastly, the detailed listing about the need for catchment management referenced two specific catchments and linked pressures related to climate change, and increased development.

Eight climate examples were listed by 7 respondents and included established climate change committees (2) and strategies (3), a strategic thematic example, and a call for assessment criteria for all local authorities. Two local authorities have established climate change committees. One committee was listed as an "inter-departmental Committee on Climate Change to address all aspects of the Council's potential impact on climate change," which suggests more of a focus on mitigation than adaptation. Of the 3 strategies, two are published and one is an internal document. The strategic thematic example consists of a local authority that "has adopted Climate Change as one of four cross-cutting themes which will underpin the development plan, the others being Sustainable Development, Social Integration and High Quality Design." Lastly, one local authority recognised the need to "determine a set of common criteria for climate change upon which each local authority must assess its policies".

Eight land use and transport examples were cited by 5 local authorities: for land use (4 respondents), transportation (2 respondents), and linking the two sectors (1 respondent). The land use examples focused on residential density (3) and mixed use districts (1). The residential density examples listed policies, compact settlements, and links between a reduced footprint and addressing the effects of changes in rainfall, travel demand, water and flooding. The mixed use districts example also linked this with travel demand and biodiversity. The transportation examples cited the need to promote sustainable transport options and to encourage public transport use. The example linking land use and transport simply stated "integration of land use and transportation".

While the awareness and sustainability category is not a traditional sector, local authorities recognise its importance. Four local authorities referenced this, with three citing the need to raise awareness. In addition to raising awareness, one local authority also cited "facilitation of Transition Towns and resilience building similar initiatives". Transition Towns are grassroots initiatives where local communities make substantial changes towards more sustainable living (Hopkins, 2011). Lastly, one local authority raised the abstract nature of climate change, and advocated that "greater effort should be made to educate all people, practitioners and the public alike, as to how to effectively deal with the issues involved".

Coastal examples from three local authorities included setback lines (2) and reported research projects. Setback lines were linked with eroding coastlines by one authority, and were linked with flood protection by another authority regarding a specific local area plan. The third local authority referenced a European funded research project where the county council worked locally with a university.

Biodiversity examples from two local authorities were a biodiversity action and "planting of native indigenous species in our planting schemes". Details were not included in these examples.

Waste examples were provided by two local authorities without direct links to climate change. One authority cited "facilitation of waste prevention and recycling" and the other cited a material recovery facility. Again, details were not provided for these examples.

Discussion about policies and actions

Overall, the examples included few details which limit conclusions that could be drawn about local authority progress in Ireland. Additional web-based searches carried out as part of this research yielded few details of specific actions being taken. For example in its survey response, one local authority noted "a strong policy". Unfortunately, there was no reference in the development plan or on the local authority's website. Similarly, many of the examples were generalised statements such as to “encourage and facilitate the use of renewable energies” or “incorporation of green energy technology and passive design in our housing schemes – attain min. A3 energy rating”.

6.3. Challenges to adaptation

Local authorities report that challenges are hindering their climate change adaptation as shown in Figure 6.7 and Table 6.1. The most frequently cited challenges for current circumstances are listed at the top of Figure 6.7, ranging down to the least frequently cited challenges at the bottom. More detailed discussion about these challenges follows.

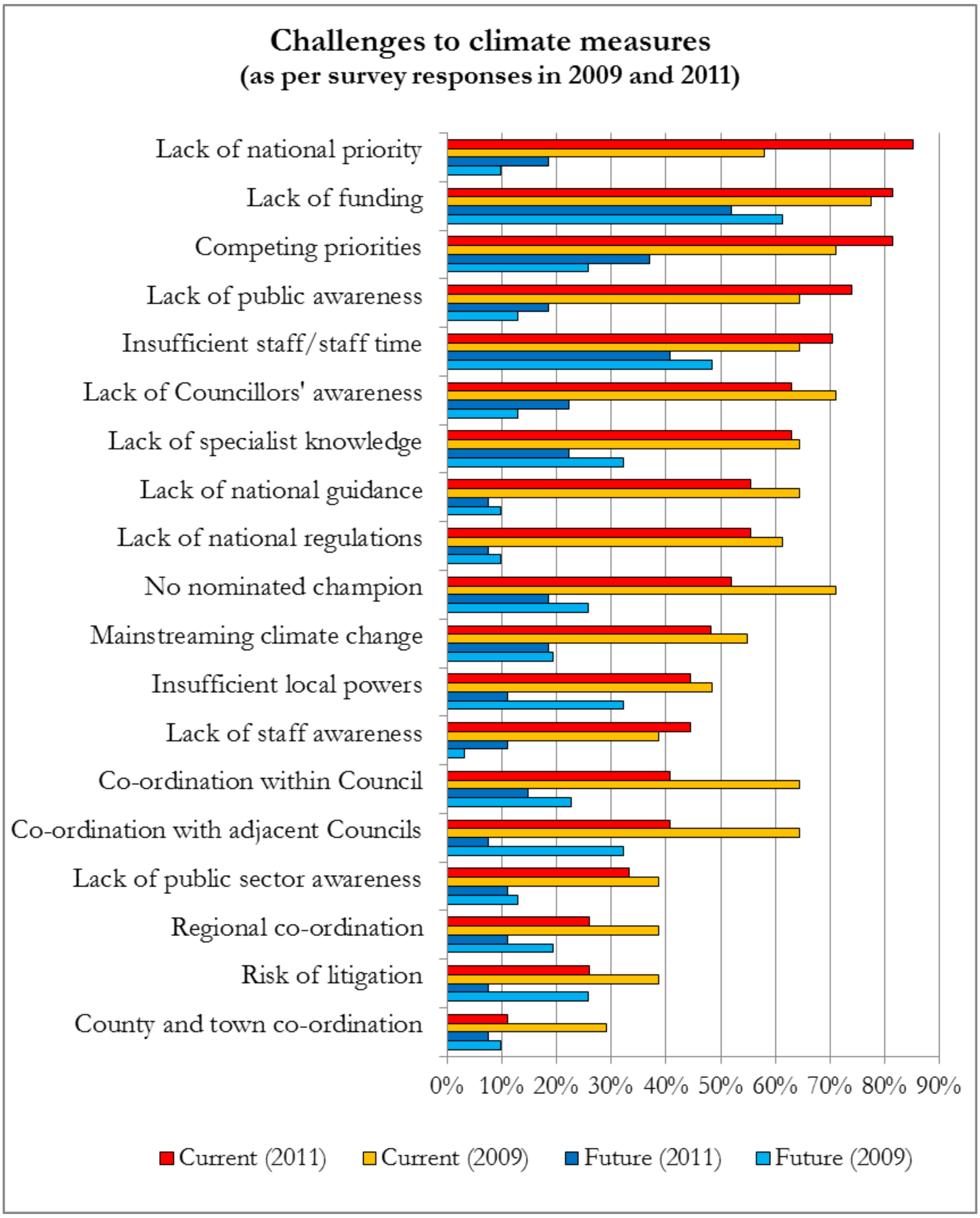


Figure 6.7 Challenges to climate measures (current and future).

These challenges confirmed by survey respondents provide useful information when considered individually and allow further insights when categorised into four main types as reported in the literature: prioritisation (e.g. Betsill and Bulkeley, 2004), resources (e.g. Moser and Ekstrom, 2010), horizontal integration (e.g. Holgate, 2007), and vertical integration (e.g. Cash and Moser, 2000. In Table 6.1 the types of challenges are listed in the left-hand column, with each challenge listed on a separate row and the relative percentages surveys in 2009, 2011 and changes between two surveys listed.

Table 6.1 Challenges to climate measures (current and future).

Challenges to climate measures (as per survey responses in 2009 and 2011)							
		2009		2011		Changes 2009 to 2011	
Types*	Specific challenges	Current (%)	Future (%)	Current (%)	Future (%)	Current Δ (%)	Future Δ (%)
P	Lack of national priority	58	10	85	19	27	9
R	Lack of funding	77	61	81	52	4	-9
P	Competing priorities	71	26	81	37	10	11
P	Lack of public awareness	65	13	74	19	9	6
R	Insufficient staff/staff time	65	48	70	41	5	-7
P	Lack of councillors' awareness	71	13	63	22	-8	9
R	Lack of specialist knowledge	65	32	63	22	-2	-10
I_v	Lack of national guidance	65	10	56	7	-9	-3
I_v	Lack of national regulations	61	10	56	7	-5	-3
R	No nominated climate champion	71	26	52	19	-19	-7
I_H	Mainstreaming climate change	55	19	48	19	-7	0
I_V	Insufficient local powers	48	32	44	11	-4	-21
P	Lack of staff awareness	39	3	44	11	5	8
I_H	Co-ordination within council	65	23	41	15	-24	-8
I_H	Co-ordination with adjacent areas	65	32	41	7	-24	-25
P	Lack of public sector awareness	39	13	33	11	-6	-2
I_V	Risk of litigation	39	26	26	7	-13	-19
I_V	Regional co-ordination	39	19	26	11	-13	-8
I_V	County and town co-ordination	29	10	11	7	-18	-3

*Types	R	Resource	P	Prioritisation	I_H	Horizontal Integration	I_V	Vertical Integration

The two main points are: 1) the most widespread challenges relate to priorities and resources, and 2) challenges will decrease in the future. Priorities are a widespread challenge that has increased over time, as shown by four challenges. First, competing priorities (at the local level) were widespread and increased by 10% (71% in 2009, 81% in 2011). Second, a lack of national priority increased by a marked 35% to become the most commonly cited challenge (58% in 2009, 85% in 2011). Third and fourth, while councillors' awareness improved slightly, public awareness declined slightly. All these factors considered together suggest that climate change is not a priority, and that local authorities are not supported in advancing climate measures.

While resources are also a widespread challenge, the trends are mixed in this area. They have increased slightly over time for two challenges, and decreased for two other challenges. The increases were for funding and staff resources, both of which were widespread and increased slightly. Conversely, decreases in concerns about specialist knowledge and nominated champions suggest increased capacity at local level. The increased capacity at local level was also reflected by fewer coordination challenges within the council and between adjacent councils.

Looking into the future, local authorities anticipate that all challenges will decrease. Some will improve slightly and others will improve much more so. Resource issues are expected to improve slightly (funding, staffing and nominated champions).

Retrospectively and similar to these Irish findings, UK local authorities face challenges in addressing climate change as shown in Figure 6.8. (The earlier Irish responses were used for comparison.) Overall, more Irish local authorities face challenges than UK local authorities even seven years later. Insufficient staff or staff time was the only barrier cited by more UK local authorities. Notably, there were extreme differences between the two jurisdictions markedly more Irish and UK local authorities reporting challenges in two areas: 1) difficulty embedding climate change into plans - 42% difference (Irish 74%, UK 32%), and 2) difficulty co-ordinating regionally between adjacent local areas - 48% difference (Irish 68%, UK 20%). Because these responses only indicated whether a challenge was present, further information about drivers was not available. These challenges were explored further in the case studies and interviews as reported in Chapter 7.

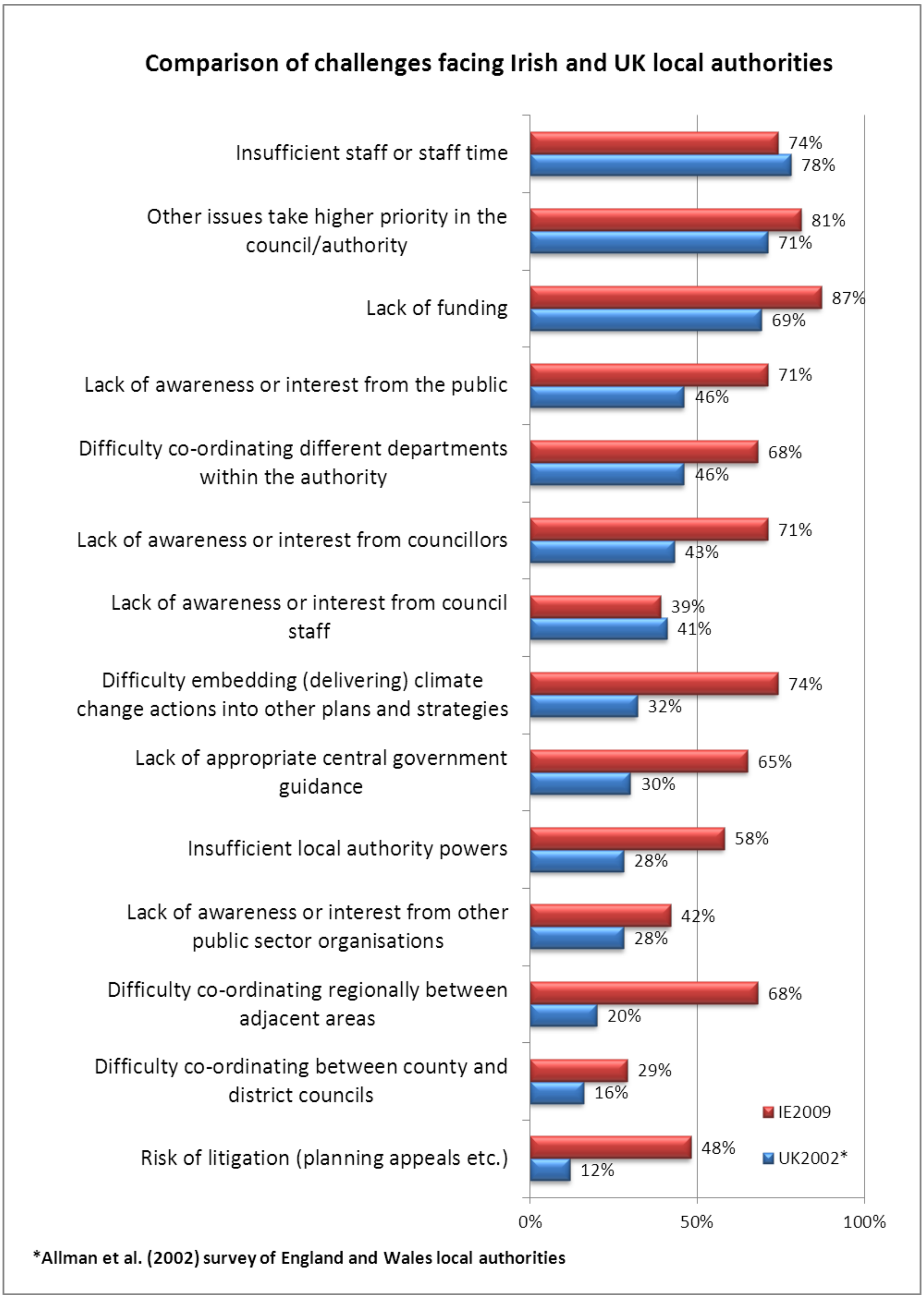


Figure 6.8 Comparison of Irish and UK local authorities

6.3.1. Types of Challenges

In addition to previous comparison of individual challenges, aggregating the information into three broad types offers a way to examine possible solutions. In addition to resource challenges and competing priorities as discussed above, integration is the third type of challenge for climate measures.

6.3.1.1. Resources and Competing Priorities

Even though resource changes are widespread and will continue in the future, local authority actions show that this challenge does not determine whether local climate measures occur. Local authorities have overcome this barrier by adding measures into development plans and adopting climate change strategies. This suggests that some authorities are capitalising on the co-benefits of addressing climate change. For example, one survey respondent noted that there are potential cost savings because "energy efficiency mitigates against issues about lack of funding".

Competing priorities relate to awareness, conflicting interests held by different actors, and other strategic issues. Awareness varies depending on the individual's role: councillors, civil servants, and public individuals. Local authorities said that climate change is not a priority for councillors or their constituents. The civil servants, on the other hand, are interested in and aware of climate change according to the results. This suggests that if a mandate came from the public, greater progress could be made. As Figure 6.9 shows, the conflicting interests were reflected when local authorities ranked the highest priorities for the areas of economic development, residential density, environmental protection, biodiversity, cultural heritage, and other.

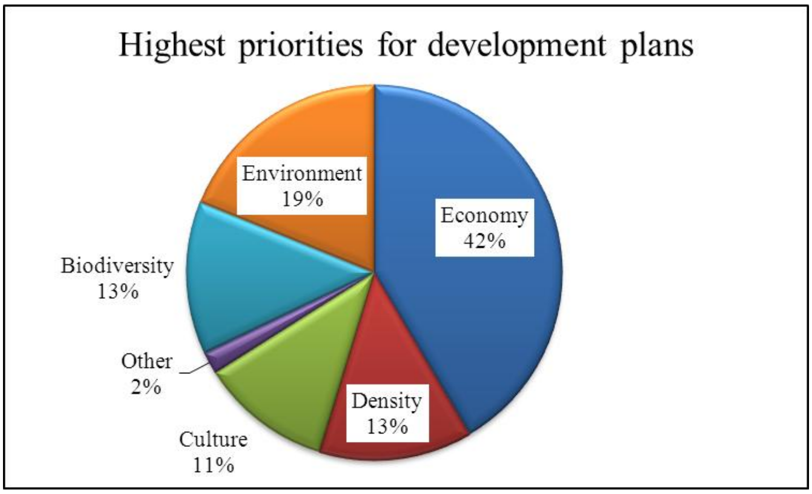
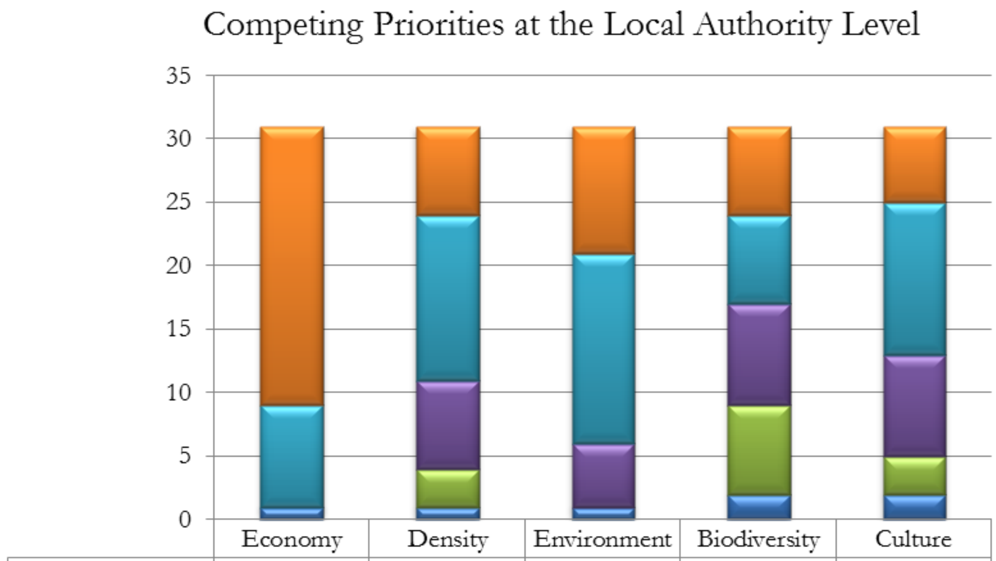


Figure 6.9 Highest priorities for development plans

Conflicting interests were reported where economic priorities superseded environmental concerns as shown in Figure 6.10.



	Economy	Density	Environment	Biodiversity	Culture
Highest Priority	22	7	10	7	6
High Priority	8	13	15	7	12
Medium Priority	0	7	5	8	8
Lesser Priority	0	3	0	7	3
Not Addressed	0	0	0	0	0
Not Answered	1	1	1	2	2

Figure 6.10 Competing priorities at the local level

These competing priorities do not, however, mean that local governments are not placing a high priority on environmental issues, with 25 of 31 respondents noting the environment as a high or highest priority (Figure 6.10). At the same time, these competing priorities constrain local action in some cases and the survey respondents perceived that the public holds a range of views. According to Respondent 18, while some farmers act as "guardians of the land", others act on the principle of "what's mine is mine". Generally, there is an "overall low level of public support; people don't really care about it".

Development plan variations were only noted by about half of respondents as shown in Figure 6.11. Given that local plans are not fully implemented (Waldner, 2009), variations are a potential measure of implementation shortfalls. Granted, these variations can be beneficial or detrimental for climate adaptation. According to Respondent 6, beneficial variations include "more sustainable development through energy efficiency in buildings" and "calculations applied to flood-risk [in which] account is now taken of the additional risk derived from anticipated climate change (10%)". Detrimental variations include one-off houses in the countryside (6 respondents) and related transport emissions (3 respondents). The other challenge noted by Respondent 4 was that "development plans can create conditions for tackling climate change, sustainable energy, and sustainable transportation patterns but they lack the real powers of implementation".

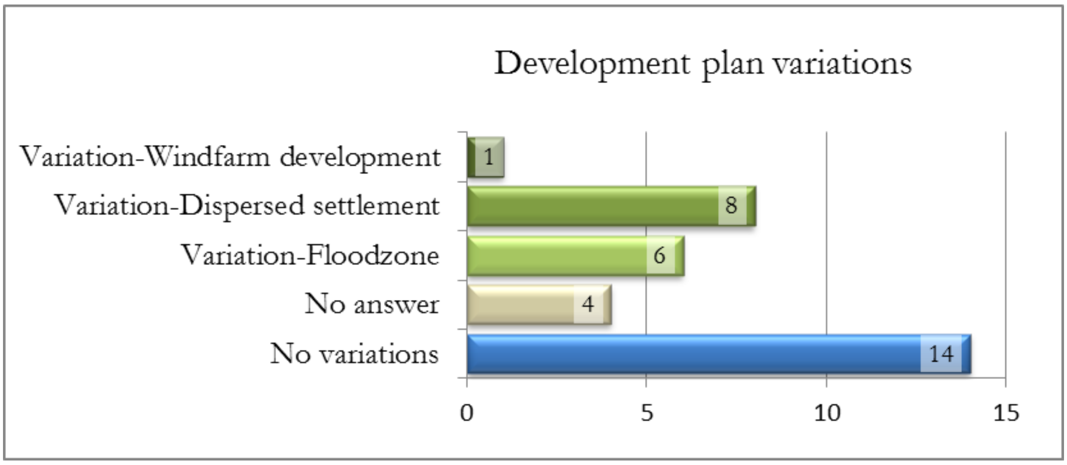


Figure 6.11 Development variations cited by survey respondents

Other strategic issues can also affect climate measures related to the sectors and how these issues are addressed. Effective policies in one area, such as guided development, can benefit other areas such as climate change:

> Reduction of the need to travel appears to be the most achievable contributor to greenhouse gases which could be impacted by more effective planning in terms of demand accommodation and guidance of development into suitable locations. This in itself would feed into improving almost every other issue mentioned such as flooding, water stresses, and pressure on habitats (Respondent 21).

The sectors of strategic issues varied in type and number and this is important because synergies can be achieved through most strategic issues. Irish local plans are not standardised for type or number of strategic issues: no two respondents listed the same combination of strategic issues. Even in cases where there were some similarities, these local authorities were scattered around the country rather than being close to one another. Overall, the most frequently cited issues were transport and settlement patterns. The number of strategic issues varied with most respondents listing 3, and responses spanned a range of 1 to 6 issues.

How the strategic issues are addressed also affect climate measures because generalised statements suggest less advanced actions than specific measures in development plans. As Figure 6.12 shows, specific measures in development plans were most commonly cited for transport and the economy, and fewer for settlement and flooding/water issues. Other local policies were most commonly cited for the environment, with most other sectors noted by some respondents. Fewer specifics were cited for energy/emissions/climate change and sustainability with general statements or no references being most common. Overall, specific measures were most commonly addressed in other local plans (29%) and, to a lesser degree, in development plans (19%) or higher level policies (9%). Specifics were not provided for 43% of the strategic issues (31% general statements and 12% no reference).

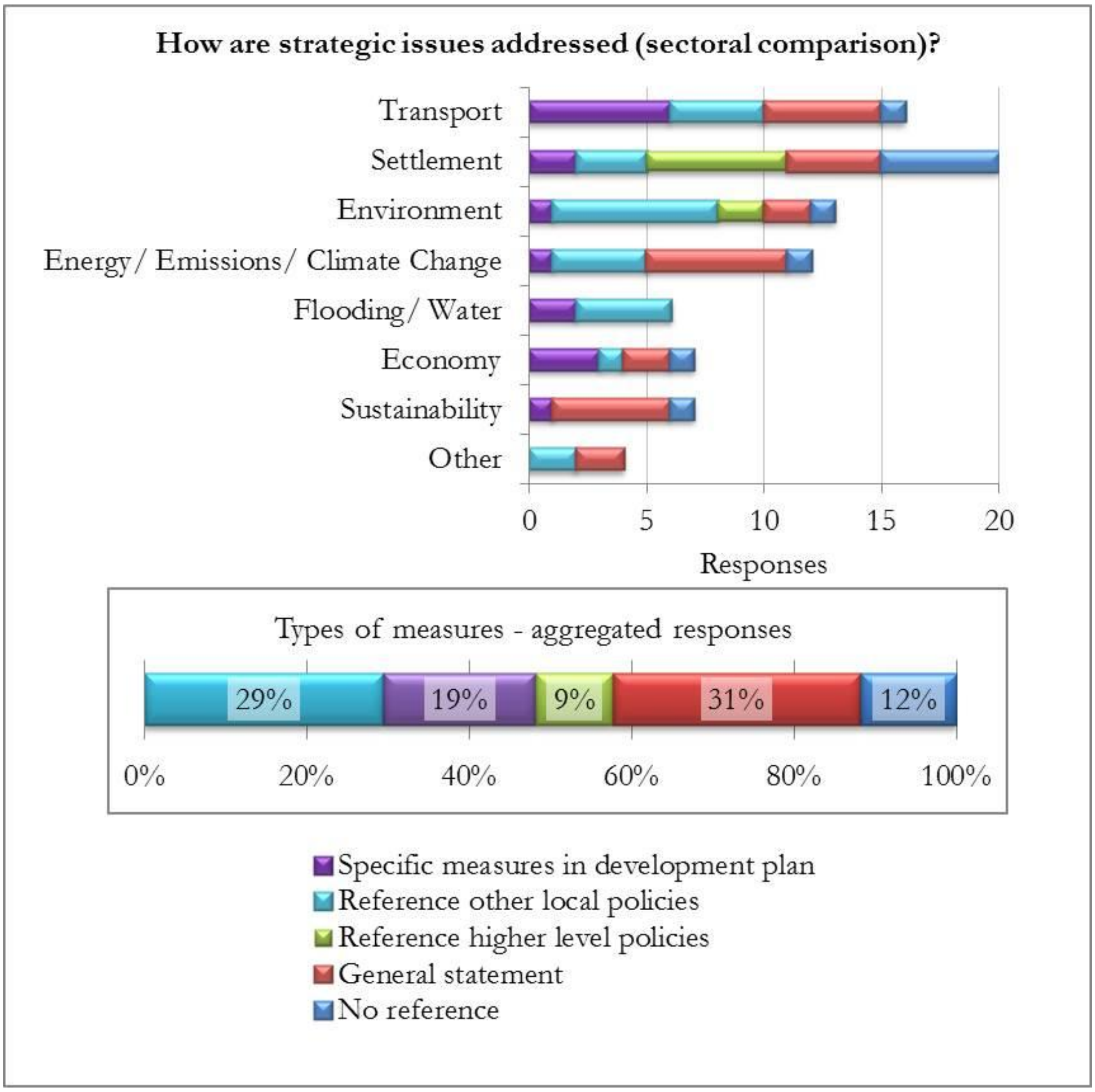


Figure 6.12 Types of measures for strategic issues by sector

6.3.1.2. Integration Challenges

Even if resource and priority challenges were overcome, integration would still challenge implementation. Horizontal and vertical integration both relate to administrative issues (termed as governance) and imperfect coordination resulting in policy gaps and/or detrimental overlaps in responsibilities. Horizontal integration relates to the links at a given level of government – both internally within an organisation (e.g. mainstreaming climate change) and externally among organisations at that level (e.g. cooperation and joint initiatives with other councils and agencies). As shown in the earlier Table 6.1, these three challenges were reported by less than half of respondents in 2011 and were anticipated to lessen in the future. Vertical integration relates to links between different levels of government both for policies and for implementation responsibilities. In terms of different levels of government, local authorities were concerned more about integration challenges with national governments than with sub-national tiers of government such as regional authorities or town councils. Lack of national guidance and regulations were cited by more than half of respondents in 2011 (see Table 6.1).

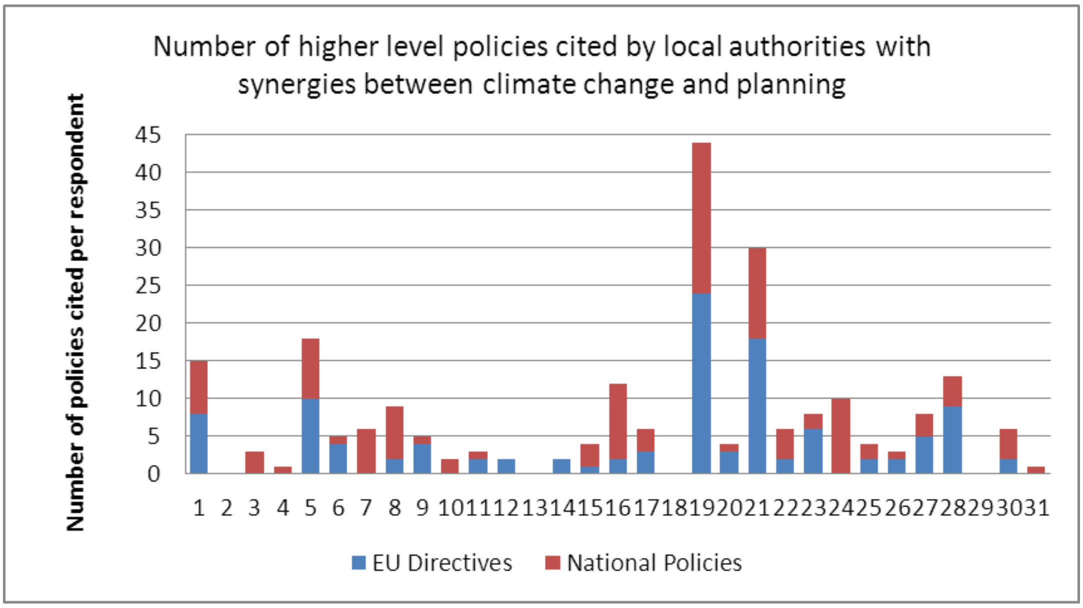


Figure 6.13 Number of policies cited by survey respondents

This perceived lack of national guidance also showed when respondents listed few higher level policies that had synergies for climate change and their development plans. As shown in Figure 6.13, most respondents listed five or fewer policies. A few respondents provided an extensive list of policies that would have synergies with climate change. Even in these cases, the specific policies being cited were not necessarily those cited by other respondents. For example, Respondent 16 highlighted 16 of 48 items on an attached comprehensive list of Legislative and Policy Framework Documents. Some policies listed by other respondents were not indicated by Respondent 16. This is one example of the lack of a standardised approach.

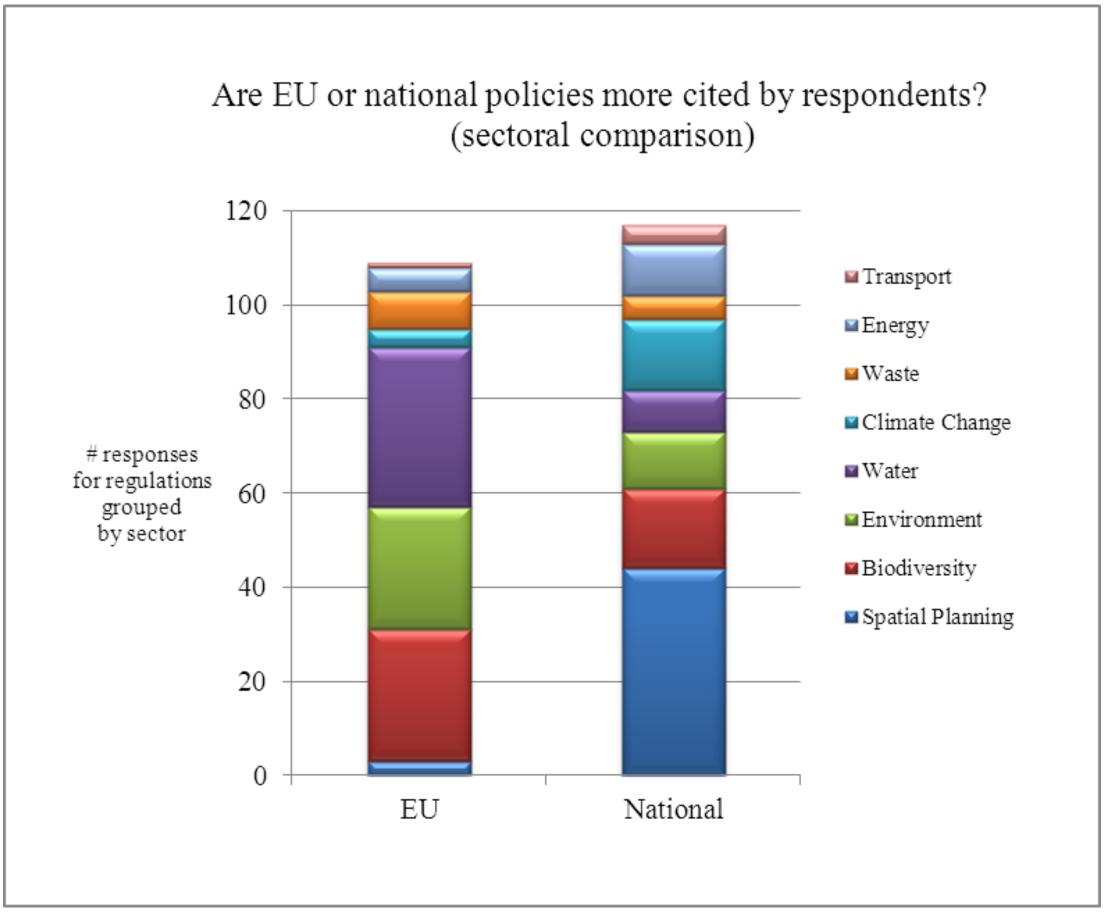


Figure 6.14 EU and national policies cited by local authorities.

Examining these higher level policies on a sectoral basis shows recognition of different roles for the EU and national government depending on the sector. As Figure 6.14 shows, local authorities acknowledged a mix of EU and national policies, with some sectors more heavily weighted towards the EU and others towards national policies. Survey respondents looked to EU policies more for biodiversity, the environment and water. They looked to national policies more for spatial planning, climate change, and energy. Overall, the Water Framework Directive was the most commonly cited EU policy, and the National Climate Change Strategy was the most commonly cited national policy. Even so, in both cases only 16 of the 31 respondents listed these policies. Similarly, very few (4 of 31) cited the National Spatial Strategy as relevant to having synergies between planning and climate change. Conversely, from a top-down perspective, clear synergies between these two policy concerns are included in the National Climate Change Strategy. The wide variance of responses from local authorities, operating under the same legislative framework, strongly suggests that national level policies are not translated to local development plans. It also indicates a lack of vertical integration regarding climate related policies.

Vertical integration challenges also cropped up when considering implementation responsibilities. The main points were a focus on local/central government, sectoral differences, and alternative perspectives about distribution of responsibilities. Local authorities and central government were the most commonly cited as responsible for implementation. The mid-level authorities such as Regional Authorities, River Basin Management Associations, and Waste Management Groupings were not reflected as primary implementers.

Local authorities perceive greater responsibility for some sectors than others as further highlighted in Figure 6.15 and expanded in Figure 6.16. Sector comparisons in perceived responsibility showed that local authorities recognised a strong role for water supply and landslide impacts. (Since the time of the survey, responsibility for water supply has been shifted to the centralised Irish Water.) They also acknowledged key roles for biodiversity, coastal issues, and flooding. Conversely, respondents acknowledged little responsibility for agriculture and increased temperatures. Overall, these responsibilities are tempered by national requirements and funding. "City/County are [sic] normally responsible for specific actions following directions from regional and central government" (Respondent 30). In addition, "the bulk of funding needed to implement solutions comes from central government" (Respondent 26).

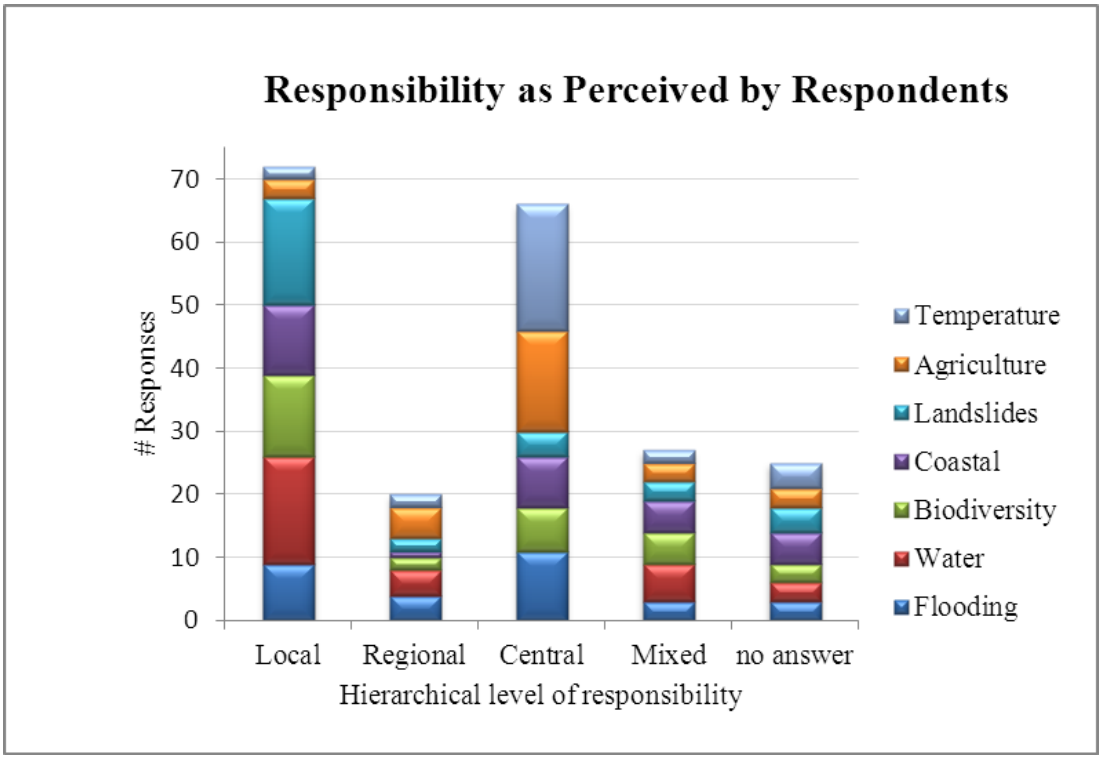
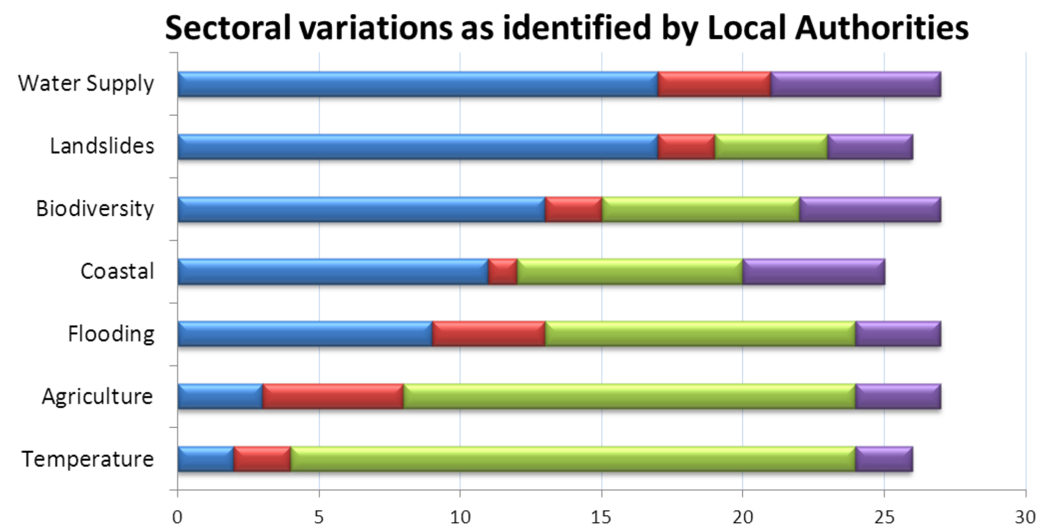


Figure 6.15 Perceived level of responsibility for adaptation



	Temperature	Agriculture	Flooding	Coastal	Biodiversity	Landslides	Water Supply
Local	2	3	9	11	13	17	17
Regional	2	5	4	1	2	2	4
Central	20	16	11	8	7	4	0
Mixed	2	3	3	5	5	3	6

Figure 6.16 Sectoral variations as identified by local authorities

Lastly, eight responding authorities set forth that responsibility was shared between local and central government, and five of these perceived shared responsibility for three or more sectors (Table 6.2). This suggests a different conceptualisation of the division of responsibilities and may represent a partial deflection of responsibility, or may acknowledge the limitations of local responses. This issue required further exploration as reported in the case studies (Chapter 7).

Table 6.2 Mixed responsibility responses - sectors indicated by respondent

		Floods	Water	Biodiversity	Coastal	Landslides	Agriculture	Temperature
Respondent	R6							
	R9							
	R11							
	R13							
	R21							
	R22							
	R23							
	R26							

6.4. Discussion and conclusions from surveys

The survey responses support a need to overcome governance challenges in order to advance local climate measures. This was shown by the lack of mainstreamed measures, comparisons with other jurisdictions with different levels of national requirements, and the most widespread types of challenges. Climate change has not been mainstreamed into local policies and operations even though local authorities anticipate their jurisdictions to be impacted by climate change. In the cases where they had mainstreamed climate change, few respondents listed transformational measures. This suggests the need for an increased long range view rather than reactive policies that merely implement higher level requirements.

These survey responses give some insight into the local circumstances as perceived by local authority planners but have three limitations: breadth, time covered, and survey execution. First, the breadth of survey respondents was limited since responses were only collected from local authority planners. Surveying a broader range of people would provide a more extensive assessment of local perceptions of climate change. Other people, both within local authorities, and the wider public, would likely hold an even more diverse range of opinions. Second, these survey results only captured the perceptions in 2009 and 2011; therefore, it is likely that opinions and circumstances will change over time as noted by Saarinen (1966) when he studied local perceptions of drought in the 1930s. Third, the survey execution was by post with limited verification of how the surveys were completed. This was offset by the use of good practice as described in the Chapter 3. Overall, these surveys provided insights about the current perceptions of local authority planners as they prepare for climate change.

Comparisons with other jurisdictions support the need for an integrated approach with strong national drivers. In the UK with its national requirements, local authorities cited fewer challenges than Irish local authorities. In New South Wales without national requirements, local authorities had undertaken fewer risk assessments and Irish local authorities. Ireland with EU requirements but no national requirements, presented a more complex situation.

UK local authorities experienced fewer challenges than Irish local authorities. There were notable differences between the two jurisdictions where significantly more Irish local authorities cited challenges for mainstreaming (Ireland 74%, UK 32%) and coordination between local areas (Ireland 68%, UK 20%). As noted in Chapter 2, the UK has comprehensive policies that include monitoring, review and enforcement (Swart et al., 2009) as well as requirements and economic incentives for municipalities (Keskitalo, 2010a). This supports the need for national government policies that include sub-national implementation details and requirements rather than generalised references to local authorities addressing climate change in their development plans.

In the other direction, New South Wales local authorities had undertaken notably fewer risk assessments than Irish local authorities in Australia (Ireland 65%, New South Wales 12%). These contrasting results were collected at a time when risk assessments were mandated in Ireland but not New South Wales. This marked difference must be considered with recognition that these results do not address the quality and extent of those risk assessments, and whether the authorities had the capacity to act on the findings of risk assessments they had carried out.

Lastly, Irish local authorities recognise higher level drivers and expect things will improve in the future. They recognise higher level policies, especially from the EU for matters related to climate change. The lack of national requirements and monitoring has resulted in different levels of local actions. Without national government requirements and guidelines for local authorities, it is unlikely that the recognition of higher level policies will be transformed into widespread adaptation. The blurred boundaries and shared responsibilities speak directly to governance issues because local authorities lack the autonomy and resources to steer the policies in their jurisdictions.

The widespread nature of the challenges shown in the survey responses, and the early stage local actions shown by the vulnerability assessment, suggest a strong need for addressing governance challenges because local circumstances prompt limited measures. This suggests that more widespread proactive climate adaptation by local authorities will require that governance issues are addressed with regard to shortfalls in national leadership and prioritisation. Addressing these governance issues will enable local authorities to prioritise environmental issues and long term strategic goals over pressing short term economic goals. The foregoing information still left questions unanswered about the potential for Irish national government to improve national drivers that will prompt local authorities to move forward.

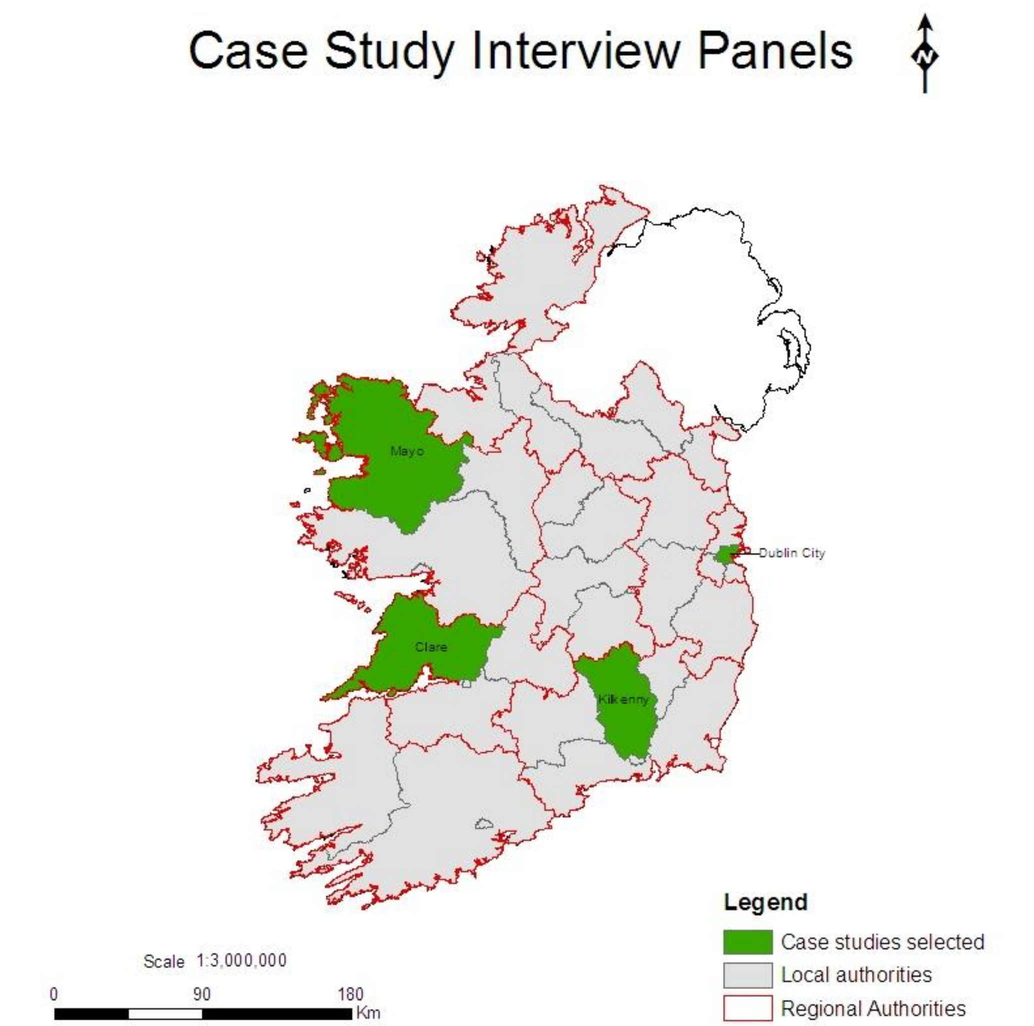
Chapter 7. Case Studies and Higher Level Interviews

These results build on the nationwide scoping exercises described in Chapter 4 (Development Plan Review), Chapter 5 (Climate Change Vulnerability Assessment), and Chapter 6 (Results from Surveys). The findings suggested local authorities were acknowledging climate change in their documents, but were actually unprepared for climate change. Further, the information regarding what prompted local authorities to act was still unclear which created challenges when drawing conclusions about possible solutions. Given the state of climate exposures and climate measures in Ireland, it is clear that governance plays an important role in advancing local climate measures. This chapter reports results from case studies of four local authorities and interviews with Regional Authority managers and senior officials in the DECLG, and concludes with an analysis of the differences between the local and national findings.

7.1. Case Study Results

The case studies focused on four local authorities and issues affecting their climate adaptation progress. The participants are identified by their role within the local authority based on the case study purpose to gain information regarding staff members' perceptions about the necessary and possible climate measures. Further, the results from the case studies focus on the lessons to be learnt for local authorities in general rather than the specifics of an individual local authority. Therefore, the results are presented thematically rather than in a case-by-case format (Yin, 2009).

Governance issues affect local actions in two ways. First, the interactions between the public and the local authority showcase the challenges faced by local authorities as they seek to adopt and implement policies in line with national agendas. This is especially true regarding environmental agendas which can be in conflict with economic priorities as shown from the survey responses. The challenges expressed by survey respondents regarding public support were further explored in the case studies in order to explore governance matters that varied among local authorities. Second, the interactions between national government and local authorities were explored both from the local perspective and the national perspective with the higher level interviews. The connections between the different perspectives highlight the importance of multi-level governance as responses from individuals at different government levels are examined. In most cases, the scale or level of the respondent reflected different priorities and experiences.



	Mayo	Dublin City	Kilkenny	Clare
City/county manager	√			
Senior planner	√	√ (3)	√	√
Engineer	√	√	√	√
Director of Water Services & Environment			√	√
Energy agency manager			√	√
Environmental awareness officer			√	
Heritage officer	√		√	
Mayor			√	

Map 7.1 Case study participants

The case study local authorities were located in different parts of the country and included a broad range of participants as shown in Map 7.1. The local authorities were well distributed throughout the country: in the west and east, at the coast and inland, and in rural and urban areas. The participants in each local authority were determined by the City or County Manager in each local authority as described in Chapter 4. While individual interviews were sought with the different staff members, in most cases the staff members made themselves available for group interviews. Four or more staff members participated in the interviews in each local authority; and seven staff members participated in Kilkenny. Most of the interviews were conducted in group panels with some additional interviews separately (Dublin City - Engineer; Kilkenny – Senior Planner, Heritage Officer, and Mayor).

These results are drawn from a mix of information provided in the interviews, review of the local policies, and web searches for information in each city and county. In some cases, general information provided in the interviews were subsidised by information from these other sources. For example, Dublin City interviewees mentioned network participation as a good practice example but did not provide specific details. In these cases, added details were obtained from other sources such as the local authority's website as referenced throughout the results section. The case study results are presented with an analysis of the themes identified from the case study interviews. Following that, the main results are grouped thematically by good practice examples, barriers, and the role of the local champion and council ethos. Lastly, conclusions from the case studies are presented in section 7.1.4.

While the overall themes and lessons to be learnt from these case studies have been aggregated into four main sections, differences were evident between the focus of each local authority and the distribution of opportunities and challenges they expressed. With regard to local authority focus, Table 7.1 below summarises the prevalence of themes, with percentages for each local authority, and for all interviews in the right column. The three most relevant themes when considering governance matters were vertical integration and the effects of local interests on climate change progress. The different responses illustrate that consideration of the local scale is important because setting out a one-size-fits-all from national government is unlikely to fit the local circumstances as discussed in Chapter 2. The perspectives of the individuals operating at the local level highlight the challenges in advancing climate measures when policies are designed at national level and implemented at local level.

Table 7.1 Distribution of statements during case study interviews

Themes from interview statements	% statements by local authority				
	Clare	Dublin	Kilkenny	Mayo	Total
Vertical integration	21%	12%	7%	38%	78%
Good practice examples	9%	26%	29%	9%	73%
Local interests hinder climate change progress	26%	12%	10%	16%	64%
Horizontal integration	14%	18%	17%	6%	55%
Strategic policy framing	11%	10%	9%	13%	43%
Resource issues for local authorities	7%	9%	7%	13%	36%
Recommendations for central government	2%	10%	9%	3%	24%
Transitional issues	5%	1%	6%	3%	15%
Role of the individual	5%	1%	6%	0%	12%

As shown in Table 7.1, the themes that emerged from the analysis showed that vertical integration was discussed most among the local authorities with a total of 78% of statements. This focus was greatest in western local authorities (Mayo and Clare), and least in eastern local authorities (Dublin and Kilkenny). Similarly while the differences were less marked, local interests hindering climate change progress was more of a focus in western local authorities than eastern local authorities. Conversely with regard to good practice examples, the western local authorities offered limited information, and the eastern local authorities spoke more about their good practice examples than any other theme. These results reflect how much each local authority focused on a given theme, but do not tell the whole story.

In some cases, few statements were made during the interviews and the importance of these factors is under-represented in Table 7.1. For example, few statements were made about the role of the individual; however, many of the good practice examples were championed by a local individual. Less tangibly, the importance of the relationship between key individuals in Clare, Dublin and Kilkenny with the other interviewees was clearly evident as will be further discussed in Section 7.1.3 below. Conversely, in Mayo it was apparent that resource challenges were hindering actions especially as regards to the lack of an effective Energy Agency staff.

With regard to the distribution of opportunities and challenges they expressed, the interview statements were also analysed as to whether the comments represented perceived opportunities or challenges. As Figure 7.1 shows, the western local authorities expressed more concerns about the difficulties of addressing climate change, whereas the eastern local authorities expressed more opportunities in their experiences.

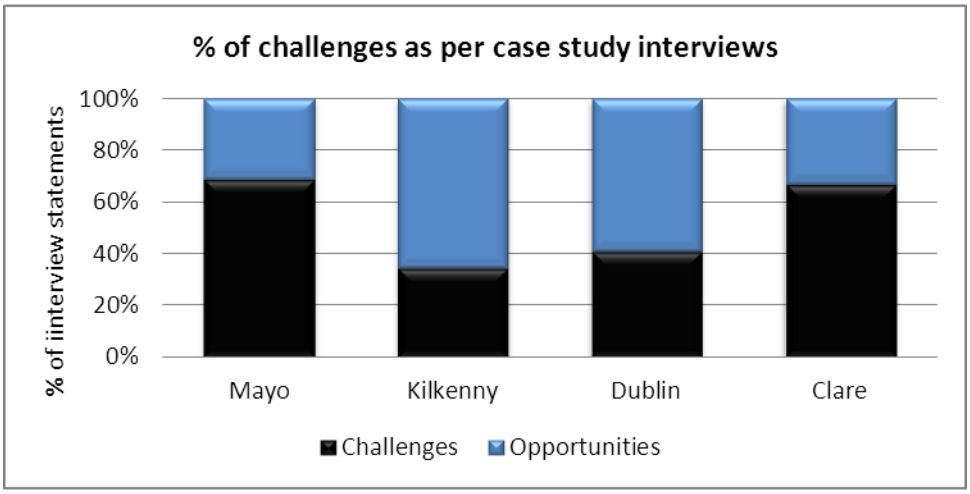


Figure 7.1 Percentage of challenges as per case study interviews

The distribution of the interview statements highlight the differences between the local authorities' experiences and confirm that the local circumstances do affect how local authorities approach climate change. This suggests a strong need for government policies to take account of the local circumstances and for national government to work closely with local authorities to support them as they move forward. In addition to the variations in approaches, the following more detailed results are presented thematically.

7.1.1. Good practice examples

In addition to policy changes discussed in Chapters 5 and 6, local authorities reported that they have adapted by raising awareness, building knowledge, and running demonstration projects. Some local authorities have stronger governance measures in place than others. For example, Kilkenny and Dublin have increased the horizontal integration of climate change measures through raising awareness and the ways they have built knowledge for climate change. Conversely, Clare and Mayo had few measures which linked with the private sector or made connections with local governments in other jurisdictions. In the first instance, there was a noted effort to raise awareness with the private sector and elected officials. For example, Kilkenny has worked with the private sector to build capacity. They raised awareness with businesses and supported local community groups such as Future Proof Kilkenny through Local Agenda 21 funding. Some examples from Kilkenny included special events, information campaigns, and ongoing programmes. Kilkenny held special events such as a local walk with Kilkenny's main street being pedestrianized for the day; which was linked by the Mayor to the ten minute city concept. "The ten minute city concept is based on the concept of access [to] all local facilities within a ten minute cycle or walk from your home" (Kilkenny County Council and Kilkenny Borough Council, 2014:159). Similarly, Environmental Awareness Officers disseminated practical suggestions through radio campaigns and information sessions in public libraries and shopping centres. Kilkenny officers facilitated the implementation of the national Green Hospitality Programme which resulted in testimonials from local hotels of "€10,000 savings in 6 months on energy costs". In addition, Kilkenny supported participation in An Taisce's Green School Programme with over 65 schools achieving Green Flag status in County Kilkenny by June 2013 (Kilkenny County Council, n.d.). Clare also supported the programme and facilitated 80 schools receiving the Green Flag (Clare County Council, 2014). Nationally, the Green-Schools programme has "over 3,700 primary, secondary and special schools in Ireland (>92% of all Irish schools) are currently participating and 2,785 schools have been awarded the Green Flag" (Green Schools-An Taisce, 2014).

In addition, interviewees provided information about building capacity through conferences and networks. They have hosted climate-related conferences and participated in climate-related networks. Both Kilkenny and Dublin City have hosted climate-related conferences. Kilkenny hosted a national climate change conference for elected members in 2008. According to Kilkenny staff members, this raised the profile of climate change and resulted in added flood alleviation works in conjunction with the Office of Public Works. Dublin City hosted the World Congress on Water, Climate and Energy in 2012. These conferences are one example of how local authorities are garnering support from elected officials, and jumping scales between local, national and international scales. Similarly, these efforts help to frame policy options towards more sustainable measures with the added benefit of increased support.

Dublin interviewees promoted the benefits of network participation in Ireland and internationally. The networks were directly related to climate change concerns for the specific areas of flooding, sustainable development, and energy management.

Dublin has built capacity through joint research projects with universities. Internationally, Dublin has joined international networks for flooding, sustainable development, and energy. For flooding, Dublin participated in EU-funded INTERREG projects SAFER, NOAH, and FloodResilienCity. The sustainable development network was Eurocities, which is an international voluntary network with the goal to shape European policy regarding climate, inclusion and recovery (Eurocities, 2013). The energy network was the Covenant of Mayors, another international voluntary network with the goal of increasing energy efficiency and renewable energy use (Covenant of Mayors, 2013a). The Covenant of Mayors example highlights the fact that actions are being taken that are not being publicised by many local authorities. Five Irish local authorities are signatories to the Covenant of Mayors (Dublin, Kerry, Roscommon, South Dublin, and County Waterford), and all have submitted their Energy Action Plan except Roscommon. Of note, the Covenant of Mayors website was last updated in May 2013, and Roscommon County Council website's most recent information was also in 2013. In the case of Dublin, this was publicised in their Development Plan. The other four local authorities made no reference in their development plans.

Kilkenny and Dublin have increased their knowledge about climate change by commissioning studies on flood risk. Kilkenny has had two flood risk studies on the River Nore: 1) an external report commissioned from Irish Climate Analysis & Research Units in 2007 as part of a Strategic Environmental Assessment for a new treatment plant, and 2) an internal Heritage Audit of the Northern River Nore. In addition, the Kilkenny Heritage Officer made a submission to the Climate Change Steering Group in 2008 regarding heritage impacts of climate change. The Dublin flood risk study was the Greater Dublin Strategic Drainage Study (GDSDS) which addressed regional drainage studies for the Greater Dublin Area including seven local authorities: Dublin, Dún Laoghaire-Rathdown, Fingal, Kildare, Meath, South Dublin and Wicklow. The GDSDS included a volume on climate change with detailed projections and anticipated impacts for rainfall, sea level rise, and groundwater. References to the GDSDS were included in Development Plans for almost half of Ireland's local authorities (16 of 34)[8]. The GDSDS illustrates the benefits of horizontal networking

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[8] Carlow, 2009; Cork County, 2009; Dublin City, 2005 and 2011; Dún Laoghaire-Rathdown, 2010; Fingal, 2005 and 2011; Kildare, 2005; Kilkenny, 2008 and draft 2014; Laois, 2011; Longford, 2009;

and cooperation in two ways. First, a coordinated effort among local authorities resulted in a more comprehensive, proactive study and set of measures. Second, through information transfer, additional local authorities were able to advance their climate change agendas.

Demonstration projects have allowed local authorities to make council properties more sustainable, as noted in interviews with Dublin and Clare. For renewable energy, Dublin and Clare have retrofitted council properties: Dublin has fitted 1500 houses with district heating, retrofitted two water treatment plants to be partially powered by renewable sources (Roundwood Water Treatment Plant with hydroelectric, and Ringsend Wastewater Treatment Plant with biogas). Dublin interviewees noted that the Dublin Kilbarrack Fire Station has become carbon neutral through a Green Plan, which reduced energy use, water consumption, waste, and CO_2 emissions (Dublin Fire Brigade, n.d.). Clare interviewees offered to show their solar thermal system and a wood chip boiler which partially power their Council offices (RVR, n.d.; County Clare Wood Energy Project, 2014).

These good practice examples confirm that local authorities are beginning to address climate change, with some taking more action than others. These early-stage actions have not developed into the long-range strategic planning that will be necessary to fully adapt to climate change. Further, the actions are more focused on advancing climate change adaptation for the local authority as an actor rather than promoting behavioural changes among the general public. This suggests that additional work will be required for effective governance to be in place with Irish local authorities. In addition, a review of the examples suggests that many of the actions are one-off events and programmes that do not represent an ongoing shift in their daily practices.

7.1.2. Barriers

The local authority interviews confirmed integration barriers as reported by survey respondents (Chapter 6). These integration barriers can be grouped into two categories: horizontal integration and vertical integration. Horizontal integration barriers relate to internal barriers within the local authority and external barriers relate to dealing

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Louth, 2009; Meath, 2007 and 2013; South Dublin, 2010; Tipperary NR, 2011; Tipperary SR, 2009; Waterford County, 2011; and Wicklow, 2004.

with the private sector. Vertical integration barriers relate to national policy shortfalls and lack of connection between national and local governments. Both types of integration barriers relate directly to multi-level governance.

7.1.2.1. Horizontal integration

Local authorities' adaptation has been hindered by horizontal integration challenges related to internal shortfalls and external pressures. The internal shortfalls include lack of funds for large-scale infrastructure projects, staff shortages, and limited knowledge about future climate impacts. These internal shortfalls have been partially mitigated by national supports which leave local authorities without increased autonomy. Large-scale infrastructure projects are not possible without national support for improving water quality (Kilkenny), retrofitting neighbourhoods (Dublin), and improving water supply networks (Dublin).

Staff shortages and information deficits have affected climate change measures in some cases, but not universally. For example, Mayo interviewees commented that they did not have the staff to prepare a climate change strategy or to go beyond mandatory minimum requirements. However, these staff shortages were not always viewed as a determining barrier. Clare interviewees stated that staff reductions have led to increased links between departments and allowed for improved cross-sectoral approaches. Regarding information deficits, Mayo interviewees cited a lack of available information regarding flood risks. They stated that the information from the OPW assessments (being carried out in conjunction with local authorities) was available only as needed in relation to specific planning applications. This presented challenges in planning for climate change because overall information for the council had not been released as yet. In addition, Mayo interviewees expressed frustration that the priorities were set by the OPW on the flood risk assessments as far as when they are carried out as well as for allocation of funding for flood protection measures. This represents a lack of effective multi-level governance in that the information being prepared by national agencies is not being effectively transmitted to local authorities, and this is compromising their ability to address climate change considerations and other environmental issues that fall within their remit.

In discussions about local challenges, the interviewees reported that external pressures related to complicating issues (highly dispersed settlement patterns, resistance to increased sustainable energy sources, and the agricultural sector) and a limited capacity to influence the private sector. Highly dispersed settlement patterns conflict with the need for sustainable transport and increased population densities as enshrined in the *Planning and Development (Amendment) Act 2010*. All four case study local authorities have been challenged by public resistance to increased residential density. According to Kilkenny's Senior Planner, 70% of rural housing applications are granted and the planners have "justified it so they can get what they want" and that "if someone wants to build in the country, there is always a way". Similarly, Clare's Engineer eloquently stated the intense pressure that rural local authorities are under: in Ireland there is a "primeval urge to live on the land". This was in the midst of a discussion about how some of the interviewees chose to live outside the town centre. The Senior Planner even noted the irony of his situation – he was advocating sustainable development and attempting to improve sustainable transportation measures yet drove to and from a neighbouring town for work each day. Additional problems were noted for transportation issues within this discussion. The local authority is trying to facilitate improved bus services within Clare; however, the highly dispersed population makes this very difficult because there is a lack of critical mass in most parts of the county. The underlying mood of the discussion was that this very difficult issue in rural Ireland is unlikely to be solved by top down regulations. The general feeling was that the Irish way of life was being threatened as supported by the comment that there needs to be consideration for quality of life as well as sustainability. Even in Dublin, the "general public opposed high density".

Mayo represents a special case regarding sustainable planning and increased population densities. According to Mayo's Senior Planner, people want to build their houses with little regard for known exposures such as landslides. This has been a challenge because councillors have petitioned on behalf of their constituents in these endeavours. Councillors also challenged sustainable planning with regard to the 2008-2014 County Development Plan. Councillors successfully challenged a Ministerial Intervention regarding rural housing policies. The resulting development plan variation represented a compromise between the Minister's original Intervention and the Councillors' permissive approach to rural development. While this example also highlights vertical integration challenges, it is important regarding horizontal integration because it showcases the pressures on local authorities as they pursue sustainable planning agendas.

Alongside the foregoing challenges, there was some positive news about transport – both for increased public transport and increased walking/cycling trails. In some cases, railway links have been reinstated such as the Western Rail Corridor, with the first phase completed between Ennis and Athenry with noted benefits:

> This new service will greatly benefit Limerick, Clare and Galway bringing more tourists into the region and greatly improving infrastructure links. Commuting to the major towns along the route will now be an easy option for those living along the route and will take many cars off the road, easing congestion.
>
> (Clare County Development Board, 2010: 1)

Even with the infrastructure in place, passenger numbers on the Western Rail Corridor have been low. Iarnród Éireann prompted increased public uptake through bookings and reduced fares in 2013-2014 (O'Hanlon, 2014). Therefore, even when local authorities support and facilitate more sustainable transport, a coordinated approach may be needed. In other cases, disused railway lines have been converted to dedicated spaces for walking and cycling such as the 42km Great Western Greenway, extending from Westport to Achill (Great Western Greenway, 2011). This Greenway received awards such as the international European Destination of Excellence (EDEN), and best Recreational Facility and best Tourist Attraction from the Local Authority Members Association (Mayo County Council, 2012). Therefore, horizontal integration is better achieved when there is also policy integration between different agendas.

Local authorities have a limited capacity to influence the private sector for matters such as farming practices and sustainable energy. For example, Kilkenny interviewees expressed concern over extremely limited participation in Kilkenny's Farm Environmental Award programme despite cash prizes being offered for participation.

Sustainable energy has been a contested area as reported in the interviews: Kilkenny "councillors blocked the wind development" even though Kilkenny has a wind energy strategy, Mayo residents opposed the Corrib gas field development, and Clare residents in the Burren area rejected a large-scale renewable energy project. According to the Limerick-Clare Energy Agency Manager, "low carbon can lead to wealth generation" which highlights the benefits of pursuing renewable energy technology. At the same time, there is a "need to recognise the environment as a resource since tourism values pristine environments". This controversy also reached national scale news when "Clare County Council expressed 'serious concerns' over the planning application" for expanded facilities at the Mullaghmore visitor centre (Deegan, 2010). These objections have not fully halted advances in renewable energies, as shown by the Renewable/Sustainable Energy Strategies in all the case study councils. Further, Clare is still pursuing a renewable energy agenda with the goal for Clare to be a "clean-tech county with the likes of the Shannon Free Zone, Shannon Airport, the county offices being powered by renewable energy" (GreenIFSC, n.d.), and permission was granted for a large scheme of 29 wind turbines (Clare County Council, 2013). The farming sector and sustainable energy challenges suggest limited alignment of goals by local authorities and the public with a resultant shortfall in effective governance especially relating to environmental matters.

Local authorities provide limited services, and this has affected adaptation in realising sustainable water treatment and amenities in general. Water treatment facilities for sewerage works on individual properties are not taken care of by central government. Instead, individual developers are installing the systems. Similarly, as noted by Dublin's Senior Planner, approved plans for housing developments include amenities; however, they are not always realised once the development is complete. These examples (sewerage works and completed amenities) highlight how the private sector affects adaptation. All of these examples have shown that local authorities have limitations which could be improved with effective national supports.

7.1.2.2. Vertical integration

Local adaptation is hindered by shortfalls in national policies, which create a policy vacuum for local authorities. These shortfalls result from incomplete implementation, both at national and subnational levels. Incomplete implementation has resulted at national level because national policies are prompted by EU Directives and regulations, where non-compliance can result in penalties. One staff member characterised national policies as "reactive policies which are not fully implemented". Another staff member attributed the lack of central government leadership to a sense of lawlessness in Ireland. In another council, there was little confidence in central government follow-through. If there was effective multi-level governance in place in Ireland, there would likely be greater alignment between national policies and local implementation.

Incomplete implementation at subnational level has resulted, in part, because the high level strategic guidelines lack details about implementation. One staff member went so far as to advocate "hard and fast regulations that preclude the local authority from granting permissions". This same interviewee cited the need for monitoring and enforcement of local authority compliance. This sentiment was echoed in another local authority with the added recommendation of greenhouse gas emission targets with yearly incremental reductions. This recommendation was made even though it was noted that legislation has reached a "raft level" where there are regulations for a plethora of issues. Similarly, within the 2014 Clare Budget: "The management of the workload of the environment section is now controlled by over 600 regulatory requirements contained in over 100 Statutory Instruments" (Clare County Council, 2014:29). Two examples were mentioned within interviews: flood regulations and light bulbs. A national level regulation for "no building on benefiting lands" would provide higher level support for minimising pressures to develop in flood-prone areas. The national government policy on incandescent light bulbs did not address local implementation. One staff member raised the issue of compatibility of new light bulbs with existing fittings as well as a lack of resources to make the transition.

The other national policy shortfall noted by staff members was a lack of support for local innovations. According to Dublin City's Senior Planner, central government has only funded to a basic standard, and this leaves local authorities with limited options to try out more ambitious measures. Central government funding does not currently include any allocation for climate change measures, and municipalities must address these issues through other agendas. Because central government funding represents the bulk of local budgets, most local authority actions are geared towards meeting minimum national requirements. Additionally, future risks must be included in current budget allocations if proactive measures are to occur. Therefore, the good practice examples listed earlier were the result of local initiatives without national support. Further, in some cases such as urban density guidelines, local councillors have cited national guidelines as justification for not adopting measures that are more stringent.

Lastly, local authorities noted that national and local policies are disconnected and that "the 'man on the street' is not taken into account with strategies". National policies were characterised as failing to accommodate "different circumstances that require different solutions". This lack of consideration for the local was attributed to a power struggle between national and local government. National government has sought to limit local power so the council was not "too big for its boots". In addition, one staff member noted that national government has failed to incorporate local input into national policies.

7.1.3. The role of the local champion and council ethos

The findings are presented with the acknowledgement that local circumstances with be different for each local authority with regard to local champions and how issues are framed within the local authority. These findings confirm that local champions can help advance measures within local authorities as reported in the United States and Australia (Bulkeley and Betsill, 2003). Local champions were evident in Kilkenny, Clare and Dublin City, and to a lesser degree in Mayo.

Kilkenny interviewees attributed their Council's proactive approach to strong support from senior staff including the County Manager and the Directors of Services. The local champion effect was also supported in the interviews with the Energy Agency Manager, the City Mayor, and the Environmental Awareness Officer where they each discussed measures that they had put forward and successfully implemented. Even in cases where a local champion helps to advance measures, successful adaptation can be threatened by competing interests as in the case of a drive for rural development, the strong agricultural lobby, and councillor objections to wind farm developments.

In Clare, the Energy Agency Manager was shown to be a local champion through measures, facilitating actions, and perceptions by other staff members. The Energy Agency Manager reported measures such as the regional climate change strategy that was prepared and instituted by the Energy Agency. This local champion was filling the role established by the local authorities to advance energy sustainability. Therefore, the local champions emerge in some cases after a general agenda had already been identified. With regard to facilitating actions, the Clare interviews in this research were only scheduled after he rallied the other staff members (initial requests for interviews had been unsuccessful). Lastly, there was a tangible respect for the Energy Agency Manager by other staff members and evidence of a strong rapport between him and the other staff members in the interviews.

Dublin interviewees also confirmed the importance of local champions through recognising that the City Manager had prioritised sustainability and it was very much in evidence during the interviews where the Senior Planner shared his visions for a sustainable Dublin City which was also reflected in the draft City Development Plan. Further, Dublin interviewees volunteered the information that elected members had been very supportive in recent times.

Conversely, the success of local champions may depend, in part, on the local circumstances. In Mayo, one staff member's proactive awareness had not been translated into effective measures or positively framed local plans. For example, the Senior Planner's recommendations were blocked by elected members with regard to prohibiting development in flood risk and landslide prone areas. Further, the council's approach to sustainable measures and general management issues was characterised by one staff member as "crisis management".

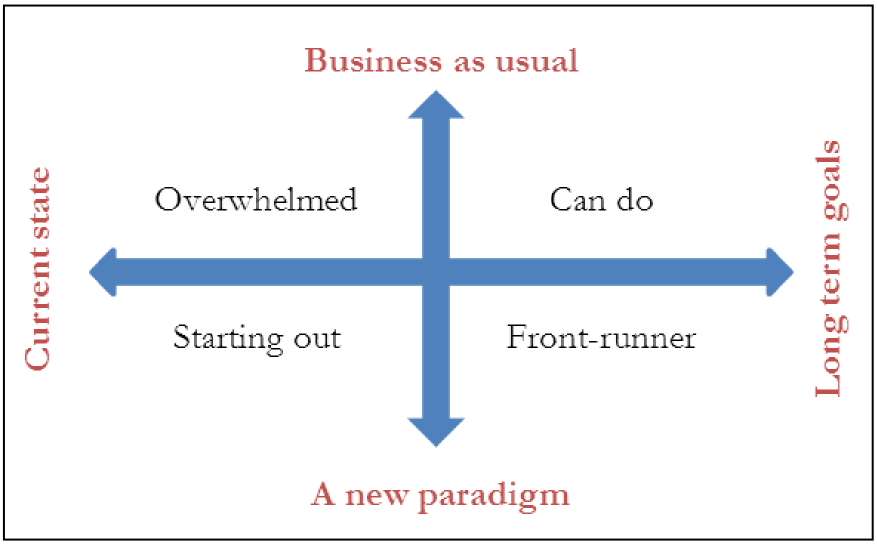

Figure 7.2 Council ethos and relationship to long term goals

Based on a comparison of these case studies, a 'council ethos' factor is proposed herein. This more intangible finding is based on observations from the interviews and confirms that each local authority has a unique experience as preparations are made for climate change. Further, each local authority had a unique approach to meeting national requirements and serving its population. Figure 7.2 illustrates these differences and places them in the larger context where some local authorities are moving forward on strategic measures towards meeting long term goals and adopting a new paradigm. Meanwhile, others have adopted more of a business-as-usual approach focusing on the current state. Mayo staff members were overwhelmed as evidenced by stated resource shortages, the need for "crisis management", and noted insufficient national support.

Kilkenny staff members had a can-do approach in that they "have to do things ourselves" without waiting for national government requirements, and the Director of Water Services explicitly stated that their basic ethos was "to plan, prepare and protect". Dublin staff members framed their council as a front-runner through networking, sustainability agendas, and strategic visions. Clare staff members presented more of a starting-out ethos where they have identified challenges such as their dispersed population which remained unanswered, as compared to sustainable energy needs which they had started addressing with their renewable energy provision in the council offices. Therefore, potential exists for local authorities to transition from a business-as-usual approach to a new paradigm that prioritises long term goals. As noted in Case Study Methodology limitations in Chapter 3, these conclusions are drawn with recognition that each local authority has a unique mix of priorities, circumstances and personnel. Therefore, any approach to facilitate increased local authorities' adaptation will require provisions in the policy design (at national and local levels) to accommodate the local circumstances.

This finding supports the need to apply the subsidiarity principle to climate change adaptation tempered with minimum baseline requirements from national government. To wit, subsidiarity is effective only to a degree, leaving a need for national supports with minimum standards. Policies are more effective when tailored to local circumstances, which can best be accomplished through design at the local level (Adler, 2005). Further, locally designed policies offer increased accountability because citizens have more of a vested interest to monitor and participate in their implementation (Jordan, 2000). If this vision is realised, actions designed at the local level will also improve governance where local authorities cooperate with the public, businesses and other stakeholders. Therefore, complete local autonomy has left Ireland with a lack of widespread actions for sustainable development, governance, or climate change.

7.1.4. Conclusions from case studies

The case studies provided information about practices, challenges, and potential solutions. The case study examples suggest that local adaptation is largely limited to building capacity through raising awareness, increasing knowledge, and facilitating demonstration projects. Limited actions were in evidence for effective governance both in terms of linkages with the private sector, international networks, and integration between local authority and national government. The case study examples also confirmed challenges to local climate measures and suggested ways to move forward on climate change. The primary challenges are shortfalls in resources, prioritisation, and national regulations. These case studies confirmed that some local authorities are acting even in the presence of these shortfalls. Information about potential higher level support was needed to give a fuller context about the governance contexts in which local authorities operate.

7.2. Higher Level Interviews

As Wilbanks (2007) and Adger et al. (2005) argue, the policies at higher levels affect and are affected by local government. Further, Irish local authorities cited a need for higher level supports and regulations. Therefore, higher level interviews were carried out with Regional Authorities and central government. These interviews focused on the potential and plans of higher level government entities to prompt more local authority measures. This research limited the focus to Regional Authorities and their role in spatial planning. The role of other sectoral entities at the regional level (such as River Basin Management Districts) is not included in the analysis. The current and planned measures by Regional Authorities and the DECLG were explored.

7.2.1. Regional Authorities

Few regional climate initiatives were found in Ireland which contrasts with reported potential in other jurisdictions. The Regional Authorities' adaptive capacity was examined in light of the reported potential in Germany (Galarraga et al, 2011; Frommer, 2013) and the United States (Knigge and Bausche, 2006). These international examples contrasted with limitations reported in Ireland (Boyle, 2000; Quinn, 2003). These findings are presented with consideration that the 8 Regional Authorities, which existed at the time of the interviews, have been dissolved and their powers amalgamated into 3 Regional Assemblies. This restructure presents a new set of challenges for Regional Authorities and their constituent local authorities as discussed in Chapters 1 and 2.

At the time of the interviews, this research presented a more mixed situation for Irish Regional Authorities with demonstrated potential as well as limitations. The two Regional Authorities studied were both participating in EU funded projects for a range of issues. In the first case, the West Regional Authority (WRA) was participating in numerous projects for community renewable energy, tourism, and economic development in rural areas (WRA, 2012). This represents a significant shift from 2010 when the WRA staff member reported no existing projects. In the second case, the South-East Regional Authority (SERA) has participated in numerous projects for youth unemployment, small-medium enterprise innovations, and communications technologies (SERA, n.d.). Different from WRA, in 2010 the SERA Director reported successful regional initiatives for regional broadband, Wi-Fi, and the Regional Craft Centre, a regional outlet featuring local designers. Also partially funded from the EU Regional Development Fund, the Creativity and Innovation in Micro Enterprises project facilitated five Business Innovation Networks. More recently, the South-East Regional Authority has adopted a *Bioenergy Implementation Plan 2013-2020* (SERA, 2013). Positively, these projects demonstrated the Regional Authorities' potential to enhance governance by facilitating regional cooperation, expanding links with similar entities in other countries, and accessing EU funds. Negatively, these projects demonstrated that the Regional Authorities' were unlikely to advance climate-related measures since the projects focused mainly on economic development rather than environmental concerns such as climate change.

As reported in the literature (Boyle, 2000; Quinn, 2003), limitations were present for both of these cases. They include the lack of dedicated resources and a dual mandate for members. The Regional Authorities were staffed by two or three paid employees with a corresponding limited budget. In addition, further staff reductions have occurred since 2012 as discussed below. At the time of the interviews, financing came mainly from EU funds and local authority budgets as noted by the interviewees. The dependence on local authorities was increased because the members of the Regional Authorities are City and County Councillors who are also serving with the Regional Authority. Each Regional Authority holds a monthly meeting of its elected members (Councillors) to address strategic issues for the region. Because the members are elected at city and county level, and serve at both local and regional levels, they have a dual mandate: they are beholden to their local constituents' interests, and they are required to serve the regional strategic interests, which may conflict with the previously mentioned local interests. For example, sensitive controversial issues, such as the location of a university in the South-East Region (and other large-scale infrastructure), pose inevitable conflicts for city and county councillors. As one interviewee suggested there is a need for directly elected Regional Members/Councillors without direct ties and responsibilities for an individual city or county. The overlapping spheres from different levels of government shows that vertical integration can be problematic, as in this case, as well as beneficial depending on how these interactions are structured.

Regional climate-related initiatives are also limited by the amalgamation of Regional Authorities into 3 standard regions for the state (DECLG, 2012d). These new regions are unlikely to be more effective in advancing core initiatives for three reasons. First, staff will still be members from the constituent local authorities. Second, the regional assemblies will not deliver services. Third, stable configurations were cited by the South-East Regional Authority Director as a key factor in advancing projects and cooperation at the regional level. When asked to explain the successes in the South-East Region, the longstanding relationships among the constituent members provided an advantage over regions that had suffered shifts in their boundaries and configurations.

Based on the foregoing, the demonstrated potential of Regional Authorities is unlikely to result in climate-related measures or prompts for local authorities without further drivers from national government. The evidence of successful regional initiatives is limited in the two examples described herein and has not translated to climate-related measures. In addition, strong limitations (due to funding and staffing issues), suggest limited potential to expand beyond the existing measures. Therefore, the benefits from improved governance are unlikely to move things forward without increased higher-level drivers from central government.

7.2.2. National government

The findings from the national interviews suggest weak governance and all highlight the importance of integration and relate to the challenges that have limited integration - horizontally and vertically. Given that the DECLG has been tasked with primary responsibility for climate change, national level interviews focused on the DECLG. These interviews were conducted between 2009 and 2012 with four senior staff members of the DECLG: two Principal Officers, a Senior Planning Advisor, and a former Minister. The interviews focused on national plans to advance climate measures and to increase local compliance with national objectives. These results bring together the input from the different interviews, coupled with insights drawn from national policy documents, and those inputs are examined in the context of governance theory.

The results are presented thematically: horizontal integration, vertical integration, and a closing discussion.

7.2.2.1. Horizontal Integration

Both Principal Officers and the Minister addressed horizontal integration with mixed opinions about successful integration. There were challenges highlighted within the DECLG, between the DECLG and other Departments, and with the wider public.

Within the DECLG there is limited integration between high level objectives and local implementation. The Climate Change Unit designs policies with a high level strategic approach; whereas, the Local Government Unit oversees policy implementation at the subnational level, and adopts a more pragmatic approach. Comparing the local government unit and the climate change unit, within interviews both Principal Officers were willing to discuss their particular responsibilities and deferred other matters to the other units. To wit, the Principal Officer of the Climate Change Unit (referred to as "N1" in this section) discussed the need for setting agendas and "moving beyond a target based approach" towards a more sustainable agenda. N1's clear vision of Ireland's end destination lacked details about the pathways: implementation matters were deferred to the Local Government Unit. Conversely, the Principal Officer of the Local Government Unit (referred to as "N2" in this section) discussed the role of local authorities to implement national policies. N2 stated that climate change objectives were under the remit of the Climate Change Unit and deferred those matters there. Therefore, an integrated approach in setting and implementing national policies was not evident from these interviews.

At national level, there are also integration challenges between the DECLG and other Departments. This represents a continued fragmented approach in addressing a single issue such as climate change which has been shown as detrimental to effective policy advancements and indicates weak governance. As noted by N1, the Minister has responsibility to broaden the DECLG's policies to other government departments such as the Department of Finance ("the Exchequer"). N1 highlighted the importance of the Exchequer in funding allocations with a comment that "they always find money for the high priority items". This suggested that a proactive agenda and approach by the DECLG would require support from other departments. The former Minister for the Environment confirmed that significant challenges were posed by other departments at the national level. According to the Minister, some departments had more power and influence within central government than others. Unfortunately in terms of advancing climate change measures, the Department of Finance's agendas were advanced more readily than other departments such as the Department of the Environment. The Minister discussed the frustration of lobbying for particular agendas such as the Climate Change Bill while in office, only to have limited uptake by other Ministers. Notably, the Climate Action Bill has not been enacted as of this writing in February 2015.

The benefits of national policies are only realised when they are implemented. This raised two issues: input and output from the government. The interviewees cited a need for public consensus as a "necessary precursor to public policies", which would activate the "great potential to advance climate measures if they are driven forward by the Ministers" (N1). The Minister went even further and identified a broader resistance to large-scale change and lack of priority on the environment by the Irish people. This perceived public apathy is in contrast to the Eurobarometer Survey about Climate Change where most people perceived climate change as a very serious problem (Chapter 1).

Adopting a more neutral tone, N2 noted that "elected members have ultimate responsibility for development plans" and have "strong impact or control on how these policies are developed". This statement goes beyond the proffered opinions of the two individuals, and the decisive role of elected members is confirmed in the Department's official Guidelines for Planning Authorities:

> Responsibility for making a development plan, including the various policies and objectives contained within it, in accordance with the various provisions of the Planning and Development Act 2000 as amended, rests with the elected members of the planning authority, as a reserved function under section 12 of the Act.
>
> (DEHLG, 2007a: 5)

Ideally, "central government's role is to clarify the message, methodology, policy and principles", "to provide a direction for laggards", and to "refocus our priorities and build consensus" (N1). This re-prioritisation requires "buy-in from the highest levels" and this would be sought by the DECLG as it moves forward on the climate change agenda. If the DECLG is successful in achieving this goal, it will require improved governance with increased integration between national and local government as well as increased integration between the public and private sectors.

Regarding the local level, N2 acknowledged challenges to integration between local authorities and the wider public. This longstanding issue prompted establishment of County Development Boards that discussed cross-cutting issues and included a mix of actors. Those Boards fell short in facilitating policy shifts at the local level, and the advisory Boards with "no power to compel implementation of actions" (DECLG, 2012b:47) were replaced with Local Community Development Committees in June 2014. The newly formed boards have responsibility for "local and community development activity previously undertaken by the County and City Development Board" (DECLG, n.d.).

Even with the foregoing challenges, some national progress has been made. The publication of the 2012 NCCAF includes a "clear mandate for the relevant Government Departments, Agencies and local authorities to commence the preparation of sectoral and local plans, and to publish drafts of these plans by mid-2014" (DECLG, 2012b:3)(emphasis added*)*. This clear mandate is only effective when acted on by other Departments and Agencies. For example, some Departments (e.g. Energy and Transport) have publicly acted while others (e.g. Health and Finance) have not. The Department of Communications, Energy and Natural Resources (DCENR) has completed its public consultation phase and is preparing the sectoral roadmap (DCENR, 2014). Similarly, the Department of Transport, Tourism and Sport has issued the *2013 Low Carbon Roadmap for the Transport Sector Issues Paper*. Conversely, an examination of the Department of Health website and the Department of Finance website shows no movement on this issue as of the end of August 2014.

These differential levels of national actions highlight two weaknesses in the NCCAF: lack of statutory backing and failure to include general Departments. The lack of statutory backing limits the effectiveness of the NCCAF because all relevant departments (e.g. Health) have not taken action as of this writing. The second weakness in the NCCAF is that it does not extend to more general departments such as Finance. Given the experience of the Department of the Environment in moving forward on the Climate Bill, there is a clear need for a fully integrated approach with all Departments. Therefore, the NCCAF limitations, the recognised lack of public consensus, and the lack of statutory regulation (the Climate Action Bill is still pending as of February 2015), suggest that horizontal integration is still lacking at national level.

7.2.2.2. Vertical Integration

National Government will need to overcome some challenges to realise the vision expressed in the 2012 *National Climate Change Adaptation Framework*. Prior to the Adaptation Framework, national government acknowledged subnational implementation shortfalls in the *Best Practice Guidelines: Implementation of Regional Planning Guidelines* (DEHLG, 2005; DEHLG, 2010a)[9] and the *Putting People First* (DECLG, 2012d). This intent has not extended to climate change as yet. Vertical integration is necessary because “mitigation strategies need to be transferred to all levels of government” and the “adaptation agenda needs to be put on a statutory footing” (N1). This has been partially addressed as a “longstanding issue” with the establishment of joint committees between the DECLG and the County & City Managers' Association as the representative body for local authorities (N2). This is crucial because local authorities have responsibilities for implementing ministerial directives (N2).

In addition to shortfalls identified above, the Senior Planning Advisor confirmed that regional governance was lacking in Ireland, and this challenge impaired integrated spatial planning and monitoring/enforcement of local plans. This Advisor met with each of the 8 Regional Authorities to advance the improved spatial planning agenda. This laid the groundwork for the *Implementation Guidelines for Regional Planning Guidelines* (DEHLG, 2010). According to the official and looking backward, there was a lack of coherence between the national strategies such as the *National Spatial Strategy for Ireland 2002-2020* (DELG, 2002) and local implementation of these strategies. This lack of coherence resulted in widespread one-off rural housing and ribbon development. Successful implementation of regional planning guidelines and strong links with local development plans were cited as the goal of these stronger policy documents.

7.3. Discussion and Conclusions

Overall, the interviewees acknowledged challenges in advancing climate-related measures and with local implementation. In many ways, each level of government cited challenges they faced and laid the responsibility elsewhere. Local authorities cited a need for stronger support from the public and national government, which would include

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[9] The *Best Practice Guidelines: Implementation of Regional Planning Guidelines* were first issued in 2005. These Guidelines were revised and reissued under the same name in 2010.

statutory backing, guidelines and funding. Regional authorities cited a need for increased autonomy through directly elected members and dedicated funding. National government cited a need for increased local implementation and a public consensus to address climate change. In addition, the civil servants looked to the Ministers, and the Ministers looked to the public. It was striking that Senior Officials at the DECLG focused on the way things should be rather than acknowledging how things had fallen short. Therefore, the interviewees confirmed the challenges but fell short of advocating a way forward. By aligning with their individual challenges, the actors at all levels are perpetuating a fragmented approach that fails to work toward the benefits of an integrated approach with strong governance structures, policies, and actions. This fragmented approach highlights weak governance in Ireland, both when considering the interactions between the level of government as well as between the public and private sector. It is striking also that none of the public officials included any commentary about nongovernmental organisations.

Considerable scope remains to advance climate measures in Ireland; however, other agendas (such as economic savings through energy efficiency) are being addressed more readily than climate measures. In addition, even though each government level identified needs that would help to advance climate measures, there were limited ideas about how to address these needs. At the current time, an integrated approach is lacking in Ireland – both when considering horizontal integration (between departments and the wider public) and when considering vertical integration with different levels of government. The newly enacted measures (such as increased statutory requirements for addressing climate change) suggest continuation of the status quo rather than transformation changes to improve governance within Ireland. This suggests that EU regulations and guidelines are likely to continue driving environmental policy in Ireland – which have had mixed results in the past.

Chapter 8. Discussion and Conclusions

8.1. Introduction

This thesis was based on the underlying premises that 1) climate change will present challenges to local governments, 2) that local governments have a role to play in protecting people and the environment within their jurisdictions, and 3) that governance factors were likely to affect how well governments could move forward on climate change. The implications of these three factors speak to environmental concerns as well as more general areas including sustainable development, democracy, and governance more broadly. The research adopted a two-strand approach of examining climate change effects on Irish local authorities and examining the usefulness of governance theory to enhance their adaptive capacity.

First, the thesis assessed the ways that climate change will affect Irish local authorities, with a specific focus on exposures and impacts for sectors under their remit. As part of this, the thesis considered whether Irish local authorities' actions would be sufficient to address projected climate change, and how higher government levels had affected their progress. This was accomplished through the following two objectives: Objective 1 identified city and county councils that faced greater challenges associated with climate change than other local authorities in Ireland. This required consideration of the different sectors and climate change overall. Objective 2 identified good practice examples and adaptation deficits by Irish local authorities, which showcased how to advance local authority policies and practices as well as provide a baseline for the current level of actions.

Second, the thesis aimed to identify factors that affect adaptation by local authorities. This required consideration of factors beyond those which are specifically related to climate change, such as administrative considerations and the wider context of higher level constraints and supports as well as external pressures from the public. This was addressed through Objective 3 that identified how adaptation deficits could be fixed through a greater understanding of governance issues.

In this chapter, Section 8.2 provides an overall thesis summary. Following this, the main research findings are summarised and discussed in Section 8.3. In Section 8.4 the limitations of the work are presented and followed by suggestions for future research. The thesis finishes with concluding remarks in Section 8.5.

8.2. Thesis summary

This thesis has investigated how climate change will affect Irish local authorities, and assessed the factors that affect local authority adaptation to climate change. This research found that challenges local authorities have faced are greater from governance issues than from those related to climate change. An analysis of local authority adaptations was conducted through the development plan review in Chapter 4. This was followed by an assessment of climate change vulnerability in Chapter 5 which evaluated the physical exposures and adaptive capacity. The vulnerability assessment was complemented by a behind-the-scenes exploration of the factors that affect adaptation. This exploration included an analysis of survey responses in Chapter 6, and case studies and higher level interviews in Chapter 7. This chapter discusses the results and draws conclusions about the implications for local climate change governance. Lastly, Chapter 9 provides recommendations for governments which are based on the findings reported in Chapters 4-7.

8.3. Summary and discussion of main findings

As discussed in Chapters 4 through 7, the results confirm subnational variations in the ways that climate change will affect Irish local authorities. It is clear from a holistic interpretation of the results presented in the foregoing chapters, that lessons can be learnt from the Irish case. Moving beyond the specifics of any one local authority, this section discusses <u>whether</u> Irish local authorities have the necessary capacity to play a significant role in addressing climate change, <u>what</u> is needed to build capacity where it is lacking, and <u>how</u> the governance theory can help to advance local actions.

8.3.1. Irish local authorities' adaptive capacity for climate change

Clearly, Irish local authorities have adaptive capacity for climate change - the question remains whether it will be sufficient for them to play a significant role. This question requires consideration of measurable adaptive capacity, explaining the drivers, and placing it in a larger context. As noted in chapter 2, adaptive capacity is an uncertain quality because it can only be measured after it has been enacted. Some evidence suggests that Irish local authorities' adaptive capacity can be measured since they have already started preparing for climate change. Therefore, Irish local authorities have adaptive capacity as demonstrated by added measures in their development plans, their adopted climate change strategies, and the demonstration projects. Further, their adaptive capacity is demonstrated by those local authorities who have gone further by adapting. For example, they have raised awareness with public information campaigns, retrofitted their own properties, and improved flood defences in cooperation with the Office of Public Works. Therefore, these actions confirm they have made a start.

This start provides a mixed verdict on whether the adaptive capacity is sufficient. The actions are early stage and how they develop over time will determine whether there will be adaptation deficits as the effects of climate change are realised over the coming decades. As noted by researchers in other countries (e.g. Bulkeley and Betsill, 2003; Wilson, 2006; Aall et al., 2007; and Mullan et al., 2013), the actions are generally falling short in terms of quality and quantity. The quality is lacking because the measures are early stage with most local authorities (and national governments) not advancing beyond setting objectives, assessing risks, and building capacity. The quantity is lacking because many local governments have still not taken action. In the case of Ireland, the quality of measures is similarly lacking because most actions are early stage; the quantity is somewhat better because most local authorities have already taken some actions. Therefore, Ireland is unlikely to be classed either as a front-runner or as a laggard regarding local authority adaptations.

The drivers of actions, and even the existence of adaptive capacity, were examined through this research indirectly. The results showed that the drivers were complex and played different roles depending on the individual actors. The information collected through reviewing development plans, surveying officials, and interviewing local authority staff members suggests that local circumstances prompt reactive responses such as flood defences rather than a strategic approach that would prepare for climate change. While this research falls short of identifying a set of solutions that will guarantee local authority adaptation, it identified some common factors of proactive local authorities. This limitation showcases the complexity of wicked problems and political realities.

The two most salient points about advancing local authority actions rest with established structures and political power. Although in many cases a local champion motivated Irish local authorities to take action, success depends on the additional presence of supportive structures within the local authority, such as cross-departmental teams, buy-in from county managers, and opportunities to innovate. The second salient point, political power, refers to the difficulty, without statutory mandates, of withstanding pressures from politically powerful individuals or groups who prioritise current economic gains or who wish to build non-sustainable houses in the countryside. Without the statutory mandates to withstand these pressures, even the most proactive and innovative individuals lack the power to enforce tough decisions. Further, power entails the ability to transform the aspirations to reality and this requires resources. Resources are necessary, but not a determining factor, to develop, implement and monitor programmes - there have been no resources allocated to climate change at the local level. Therefore, within the current context, local authorities are unlikely to make significant progress on climate change. This is less of a pressing issue at the moment since the effects of climate change have not been fully realised. The danger is that the actions that are being taken now are investing resources and developing infrastructure that will not be appropriate when those effects are fully realised.

The larger context of Irish local authorities' adaptive capacity concerns the roles allocated to them, the highly centralised nature of Irish government, and the uncertainty of climate change. The roles allocated to local authorities have been prescribed and controlled by central government. Further, many environmental protection measures have been driven by EU Directives rather than Irish initiatives. First, local authorities have been charged with implementing national policies which included safeguarding people and the environment within their jurisdiction. This operates within the larger central government remit with overlapping responsibilities and imperfect accountability. The overlapping responsibilities make it unclear where the local authority has autonomy and where national government should take the leading role. For example, flood protection requires significant expertise and financial investment and has been largely the responsibility of the national lead agency the Office of Public Works. At the same time, local authorities are the first responders to flood events and have a responsibility for sustainable planning. Both issues about implementation and overlapping responsibilities are further complicated by a lack of coordination between national and local governments, with limited input from local to national level. Even though the CCMA provides a conduit for local officials to give into to national level, the evidence from this research shows a predominantly top-down approach to policy design and implementation. Further, the lack of support for local innovations and local input into national policies suggests a constrained potential for local authorities to be proactive in their areas for both general issues as well as less popular environmental issues.

The imperfect accountability has been addressed recently to some degree. The DECLG has strengthened requirements for local development plans. They must now be consistent with national objectives and regional strategies including core strategies for population density. The DECLG require local authorities to address climate change mitigation and adaptation in their development plan. These requirements are only the first step, and their effectiveness will be determined by monitoring and enforcement. Therefore, strong national drivers are still in the early stages.

Overall, Irish local authorities' adaptive capacity shows potential which will need further development in order to prepare for climate change. The previously lacking information about the state of Irish local authorities' climate change measures has been significantly expanded with this research through the vulnerability assessment and compilation of good practice examples. This research gives a baseline, shows where adaptive capacity is lacking, and highlights the need for further improvements.

8.3.2. Enhancing adaptive capacity where it is lacking

The baseline assessment and the case studies showed a need for expanded adaptive capacity among Irish local authorities, including challenges related to information and governance challenges. The complexity of climate change requires high quality, high resolution data which gives the user the ability to assess the interactions between the sectors and the cumulative effects of sectoral impacts. Because of resource limitations, the current data is lacking both in quality and in coverage (e.g. details about recorded events and high uncertainty levels). The coverage is lacking in that collection practices were not equally applied in all areas e.g. coastal erosion and landslide data shortages in the west. The usable information has not been available for local authorities' use, and it has not been framed at the local authority scale. These data shortfalls resulted in limitations in the assessment more generally due to uncertainties in the climate vulnerability assessment. Resolving these uncertainties would require extended datasets as well as more detailed assessments for the sectors.

This study has shown that information needs are not easily resolved for local authorities. The vulnerability assessment addressed the need for more information about climate change exposures and impacts but seemed unlikely to prompt an increase in actions. The lessons to be learned from this assessment were mixed. On a positive note, based on the feedback, it was confirmed that local authorities are already aware of the challenges in their area. Further, the vulnerability assessment confirmed sub-national variations in exposures, impacts and capacity. The assessment also highlighted the absolute exposures and vulnerabilities on detailed examination of the results. Lastly, there were benefits to the format of the results regarding mapping and summary sheets. The mapping translated numerical data into a more approachable format for the local authority staff members. The summary sheets highlighted the relevance of the different sectoral exposures to climate change. On a more cautionary note, there were difficulties related to relative exposure and to local authorities' planning needs. Ideally, a relative ranking format facilitates a transition from reactive planning (with a narrow focus on the local areas) to proactive planning (with a broader focus of greater exposures in a national context). However in practice, the relative ranking format was more useful to start discussions and raise awareness. It was not useful to plan for adaptation due to limited measurability of exposures and impacts. In cases where a local authority had low exposure, it was perceived that the elected members would use it to justify not taking action. In cases where a local authority had high exposure, detailed projections would still be needed e.g. engineering standards to design bridges. Overall, there were two main benefits to this assessment. First, the assessment illustrated that plans will need to take account of areas with greater and fewer exposures and impacts. Second, the need for addressing administrative structures was clearly demonstrated.

The governance structures were raised in that the most widespread challenges related to the generalised capacities of local authorities rather than specifically to climate change. Further, the limited progress with other agendas, e.g. sustainable planning, spoke to government failures as discussed in the governance literature.

8.3.3. Governance theory and local authorities' adaptive capacity

Governance theory offers a framework to assess climate measures beyond the narrow lens of climate change with a focus on integration and the role of local authorities. At the same time, application of governance theory must be tempered with recognition that local actors can overcome many of the challenges presented by governance failures.

External pressures have mixed effects on effective climate change governance. As discussed in Chapters 2 and 7, external pressures showcase the effects of, and the need for, effective governance with strong horizontal and vertical integration. With regard to horizontal integration, Ireland's progress is limited due to fragmented government structures and an identified lack of public consensus. The government structures are fragmented at national level as shown by the DECLG's responsibility for climate change without similar consideration by other Departments. Further, links between the Departments are lacking which could be overseen by the Department of the Taoiseach. This fragmentation at the national level extends was also shown through the DECLG's prescriptive approach without details about achieving the long-term strategic goals. The local fragmentation is shown by the absence of dedicated resources, climate change committees, and limited co-ordination with the public. This lack of formal links leaves climate change to be addressed in an *ad hoc* manner, if at all. In addition to fragmentation within the government and lack of engagement with the public, a corresponding lack of public consensus was acknowledged at national and local levels. This fragmentation has resulted in the DECLG's proposed plans not being realised. Therefore, the level of horizontal integration is echoed by the level of climate measures – very limited.

With regard to vertical integration, inputs have prompted actions by national and local governments. EU pressures prompted the Irish national government to move forward on the pending *Climate Action Bill* and the 2012 *National Climate Change Adaptation Framework*. This positive effect has limitations: binding targets are absent from the Bill and implementation details are lacking in the NCCAF. Local authorities have also responded to higher level pressures. Since the *Planning and Development (Amendment) Act 2010*, local authorities have increased their address of climate change within development plans along the lines advocated by the revised statute. As in the National Government case, the actions are limited to early stage actions of setting objectives and adopting strategies. The requirements are that local authorities include references to climate change, but do not extend to specific measures, targets, or accountability. Few local authorities have moved beyond a token acknowledgement of climate change into their plans even for flooding or biodiversity. Therefore, the actions prompted from higher levels evidence weak governance with imperfect vertical integration and inadequate climate measures.

The links between the role of local authority and governance theory permit a greater understanding of the limitations and potential solutions to enhance local authorities' adaptive capacity. This framework broadens the focus to include local actions including implementation and innovations. This is vitally important because local actors are moving forward despite national shortfalls in steering society towards climate-proofed infrastructure, policies, and behavioural patterns. In other words, despite the negative effects of limited integration, the good practice examples demonstrate that some progress is still possible. For example, some local authorities had begun taking actions without prompting from national government, such as climate change strategies, added measures in their development plans, demonstration projects, and some awareness-raising with the public. This progress is insufficient because the good practice examples have not been translated into standard practices by most local authorities.

8.4. Current limitations and suggestions for future research

The current research has contributed to knowledge about climate change vulnerability and shown the importance of considering governance theory for meeting the many challenges facing society. This research has provided a starting point to assess climate change vulnerability at the local authority scale and further research is warranted to inform specific plans. This research suggested that local authority adaptation has been driven to a limited degree by local circumstances but not to a point where widespread climate measures have been adopted. Therefore, it is suggested that higher level requirements will be required to strike a balance between setting minimum requirements and leaving local authorities sufficient latitude to tailor policies to their local area. This research confirmed Jordan (2000)'s point regarding the subsidiarity principal that further research is needed with stakeholder involvement to develop pathways to increase local authority adaptation.

The current research would also benefit from an expanded assessment of vulnerability based on consideration of other socio-economic factors. The information provided in this research addressed local authorities and their service provision but excluded consideration of actions by individual members of the public, interest groups, and private enterprise. Addressing the socio-economic factors would facilitate an expanded assessment of the people living within the local authority areas and facilitate considerations for resource allocations by national government. This would also facilitate issues about prioritisation at local and regional levels where existing demands and responsibilities have prompted unfavourable compromises between economic priorities and climate change considerations. Further, assessing the vulnerability of individuals would highlight added issues about equity that local authorities need to address.

Governance has been highlighted as a key socioeconomic factor by the IPCC (2014) and this research has confirmed the importance of addressing the administrative factors of individual actors as well as the interactions between them. This echoes the earlier calls for an integrated approach within the natural hazards research (e.g., White, 1945), regarding social vulnerability (e.g., Saarinen, 1996), and for climate change research (e.g., Wilbanks and Kates, 1999). Challenges still remain in identifying the interplay between external stimuli related to environmental challenges and external stimuli related to public opinions. This research opened discussions with governmental officials seeking to clarify the driving forces that drive forward action. The importance of addressing governance shortfalls, e.g. lack of an integrated structures and lack of engagement with other actors, has highlighted the need for a continued integrated approach that brings together the physical environment and the socioeconomic factors.

The other main point about governance that has been raised by this research relates to the importance of multiple levels of actors and structures. As the research has shown, the conclusions drawn will be very different depending on the level of the analysis. Further research is needed to expand this multi-level framework to include communities and individual households.

8.5. Concluding remarks

This research has contributed additional knowledge to the Irish context and examined the importance of governance regarding climate change and more general concerns for governments and society. With regard to the Irish context, the research has shown that the exposures, impacts, adaptive capacity, and adaptations vary at the subnational level in Ireland. The current lack of widespread climate measures leaves Ireland with residual climate vulnerability. Ireland will need to overcome challenges related to its current government structures, if it is to protect its people and the natural environment. There are three main considerations with regard to the adaptive capacity shortfalls: 1) each level of government has different challenges and opportunities, 2) shortfalls in vertical integration (links between the levels), and 3) shortfalls in horizontal integration (breakdowns within each level). The related implications for Ireland are equally applicable to climate change and other EU environmental directives.

As local authorities build their capacity and move forward on climate change, they can also use their increased capacity to make a transition from policy implementer towards a more autonomous, proactive agency. Local governments can and should use existing good practice examples to guide their actions as they move forward. These good practice examples can expand to include greater facilitation of actions by the public. With increased participation by members of the public, there is increased potential for improved democracy as they become more involved with new projects for their benefit. This gives a template for action and offers further benefits. When a local authority applies good practice examples from neighbours, the adopting local authority has opportunities to make further improvements and showcase how these examples can fit more than just one circumstance. These new measures can also benefit other policy areas and will further advance climate change adaptation by maximising the synergies with those other policy areas. For example, improved actions for climate change will also benefit sustainable development with its concerns for the environment, economy and social factors. This will enable the transition without overtaxing the local budgets and existing staffing levels.

Lastly, the foregoing capacity building does not occur in a vacuum. As the current research has shown, this transition will not be solved with a quick fix or a one-time solution, but rather will be best served by an integrated approach linking together local expertise and innovations with a high level strategic approach from central government. Either approach on its own will fail to make the added transition from aspirations to adaptation. Central government can help move towards an adapted Ireland by providing detailed guidelines with statutory backing and accountability. These guidelines must strike that balance between accountability and allowing sufficient adjustments to accommodate local circumstances. By monitoring and enforcing improved standards, both proactive and other local authorities will be prepared for climate change.

The foregoing adjustments align with necessary changes for improved governance. The good practice examples presented in this research are a starting point for knowledge transfer and can be expanded through continued and expanded interactions among local authorities in Ireland and abroad. The proposed local authority checklist template in Chapter 9 provides a framework for accountability, baseline assessments and improvements. The recommended exploration of synergies between climate change and other policy agendas can facilitate increased coordination both within government agencies and with the private sector. Lastly, in accordance with the principles of multi-level governance where the interactions between local and national actors can compromise or improve effective policies, improved guidelines and accountability will provide the necessary support for increased local actions. By improving governance, Ireland improves its potential to safeguard its citizens and the environment from longstanding concerns, external pressures, and uncertain future challenges.

Chapter 9. Recommendations for government

This chapter is dedicated to addressing policymakers' needs for concrete actionable measures that can be implemented by government. These recommendations, which have received approval from national stakeholders and were published by the Irish Environmental Protection Agency in 2013 (McGloughlin and Sweeney, 2013; Sweeney et al., 2013), address the challenges that are preventing an integrated approach as identified in this thesis. This chapter addresses these challenges related to climate change and wider governance concerns. Within the existing government structures, each entity must adapt policies and daily practices. Local government should expand on existing good practice examples, regional government should coordinate local actions with a mid-level strategic approach, and national government should steer policies and provide statutory backing to advance action at all levels. Overall, the following recommendations address the challenges at each level and through integration.

9.1. Local Authorities

By planning ahead for climate change, local authorities should contribute to a more comprehensive climate change policy throughout Ireland. If they do not take action, they will be forced to adapt reactively, that is, respond to events after they have already caused damage, without becoming prepared for future events. Local authorities should address climate change in the following ways:

- Build adaptive capacity by sharing information among local authorities through web-based tools and databases, published reports, and targeted conferences.

- Establish structures such as a climate change team, a climate change strategy and specific measures in general policies. The climate change team should include Directors of Services and the County Manager, and report progress in the monthly council meetings. The climate change strategy should include concrete measurable actions for both climate mitigation and adaptation. General policies should incorporate specific climate change criteria into relevant areas, such as development control, flood management, and amenity. The template checklist below in Table 9.1 provides a starting point.

Table 9.1 Climate Change Checklist Template for Local Authorities

	Necessary actions	Timeline
Climate mitigation	Collect baseline data, broken down by department, on energy use and emissions Set clear objectives and targets for reducing energy use	
Risk assessment	Identify potential local climate change issues Identify which risks will require a response Identify sectors requiring a more detailed risk evaluation (built environment; cultural and religious heritage; local business, industry, and economy; energy generation and distribution system; health-care facilities; land use; transportation system; parks and natural environment; and tourism)	
Build capacity	Council staff members to attend workshops and trainings for mainstreaming climate change into their specific responsibilities Hold a series of workshops to build knowledge base among local government leaders, chief executives, and elected representatives to foster unity of purpose	
Establish structures	Establish a cross-departmental team, staffed by senior management, with responsibility for taking action on climate change Establish a framework for evaluating, measuring and monitoring progress	
Monitor progress	Incorporate reports from the climate change strategy team into monthly council meetings Incorporate departmental reports about climate change activities into the local authority's annual report	
Build public consensus	Designate responsibility with an individual or department for communicating climate change Carry out public information campaigns through public service announcements, leaflets, schools and community groups	

● Monitor progress by publishing specific, measurable targets for climate mitigation and adaptation. Initial requirements could be less rigorous, if necessary, such as a specific objective to prepare a climate change strategy within the lifespan of their current development plan.

● Report progress within annual council reports and budgets regarding voluntary and mandatory measures.

9.2. Regional Authorities

Regional government has the potential to advance climate measures, even in its current role as a facilitator, in the following ways:

- Serve as an information clearing house for local authorities.
- Oversee local authority climate change strategies.
- Coordinate regional climate change strategies.
- Establish directly elected regional representatives, with a remit solely for regional level policies. These posts are the European norm and will require additional resources and structure.

9.3. National Government

National government should establish enforceable minimum standards and join together with sub-national government to facilitate an integrated response as follows:

- Adopt legislation that will clearly prioritise climate change and advance climate measures at national, regional, and local levels.
- Establish and enforce specific, actionable standards for regional and local governments.
- Include climate change criteria and concrete climate change adaptation measures in national policy documents to increase transparency.
- Continue raising awareness to build public consensus. Without a public consensus to move forward on climate change, there will be no mandate for the elected representatives to prioritise this issue. This will leave Ireland in its current position of reactive management, largely driven by EU Directives and sanctions.
- Monitor progress through specific measures, including baselines, benchmarks and annual targets.
- Report national progress annually by Departments and in the annual address by the Taoiseach (head of the Irish Government). Annual reporting will increase accountability, give national government an opportunity to highlight its progress, and build further public support. Alternatively, if progress is not being made, then annual accountability will provide opportunities for early intervention and corrections.

9.4. Integration

Government bodies should improve governance by integrating their climate change plans both vertically (from supranational to national to local) and horizontally (e.g. between one local authority and another). Vertical integration should be facilitated as follows:

● Maintain the Climate Change Working Group, with representatives from local authorities, energy management agencies, Office for Local Authority Management, and the DECLG.

● Incorporate explicit links to other government tiers within policy documents at each level.

Horizontal integration should be facilitated as follows:

● Establish an internal climate change team at each level to oversee the directorates' climate change actions with specific responsibilities for each department.

● Establish cross-sectoral fora at all levels (national, regional, and local). This should minimise maladaptation, increase knowledge transfer, and strengthen potential synergies between different agencies with their separate agendas.

● Establish formal links among similar authorities in different jurisdictions at each level to address climate change. This should build capacity through knowledge transfer and increase potential synergies between adjacent jurisdictions.

● Incorporate climate change criteria into annual assessments.

The foregoing recommendations are the first steps towards effective adaptation to climate change. They include specific points for each existing government level as well as points to improve integration vertically between the different levels of government and horizontally within government and with the wider public. Each recommendation should be considered on its own merits as well as within the full scope of recommendations. Adaptation measures will need to be assessed and implemented on an ongoing basis with adjustments and improvements as experience and knowledge increases. Moving forward on adaptation will also benefit wider societal agendas through improved governance practices.

Future prognosis: Ireland has begun laying the groundwork to address climate change and will need to continue on this path with increased commitment. This will require national government to establish clear priorities through legislation with specific requirements by local authorities and private entities. Without this shift, Ireland will remain unprepared for the upcoming challenges related to climate change and general environmental issues.

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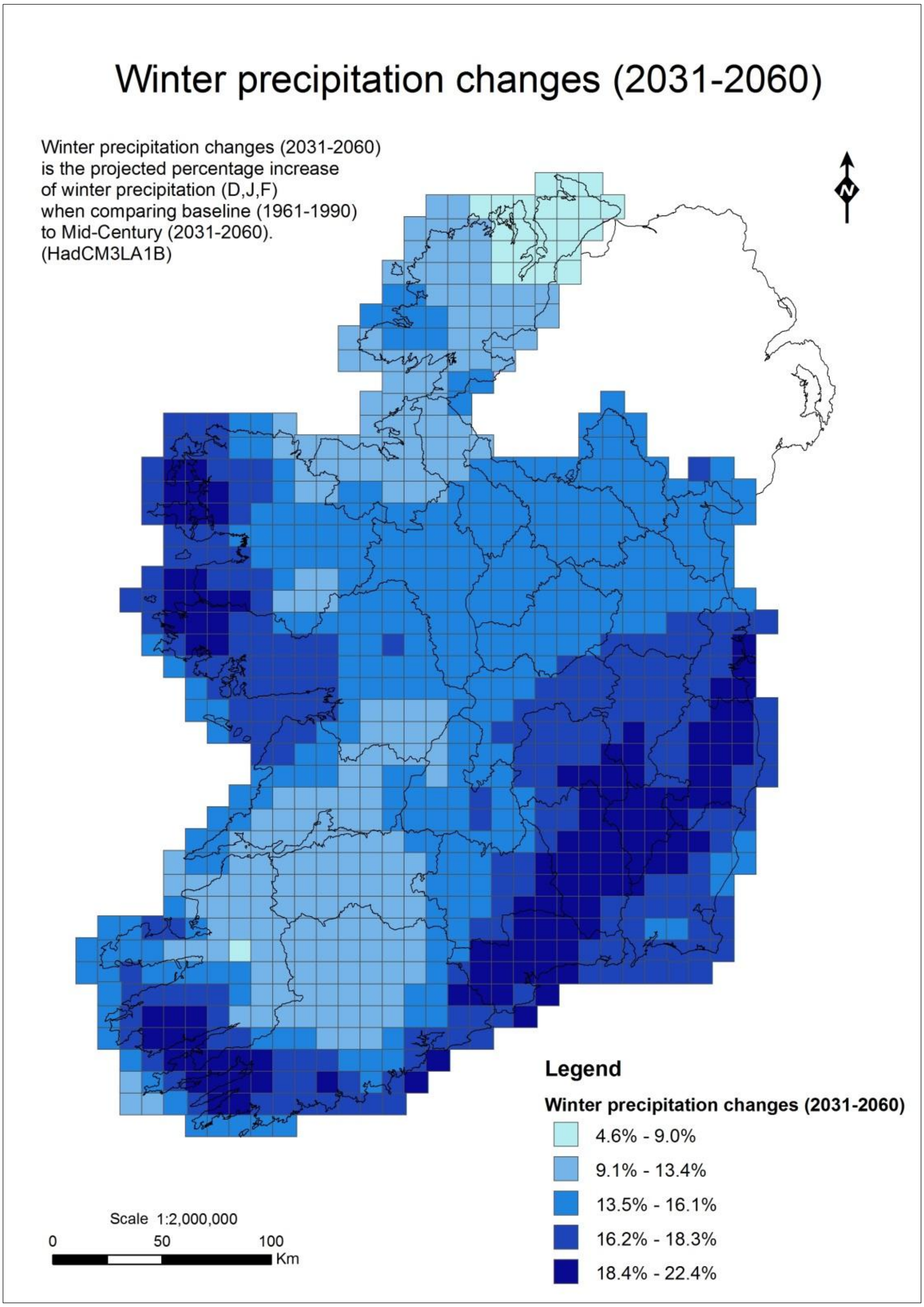
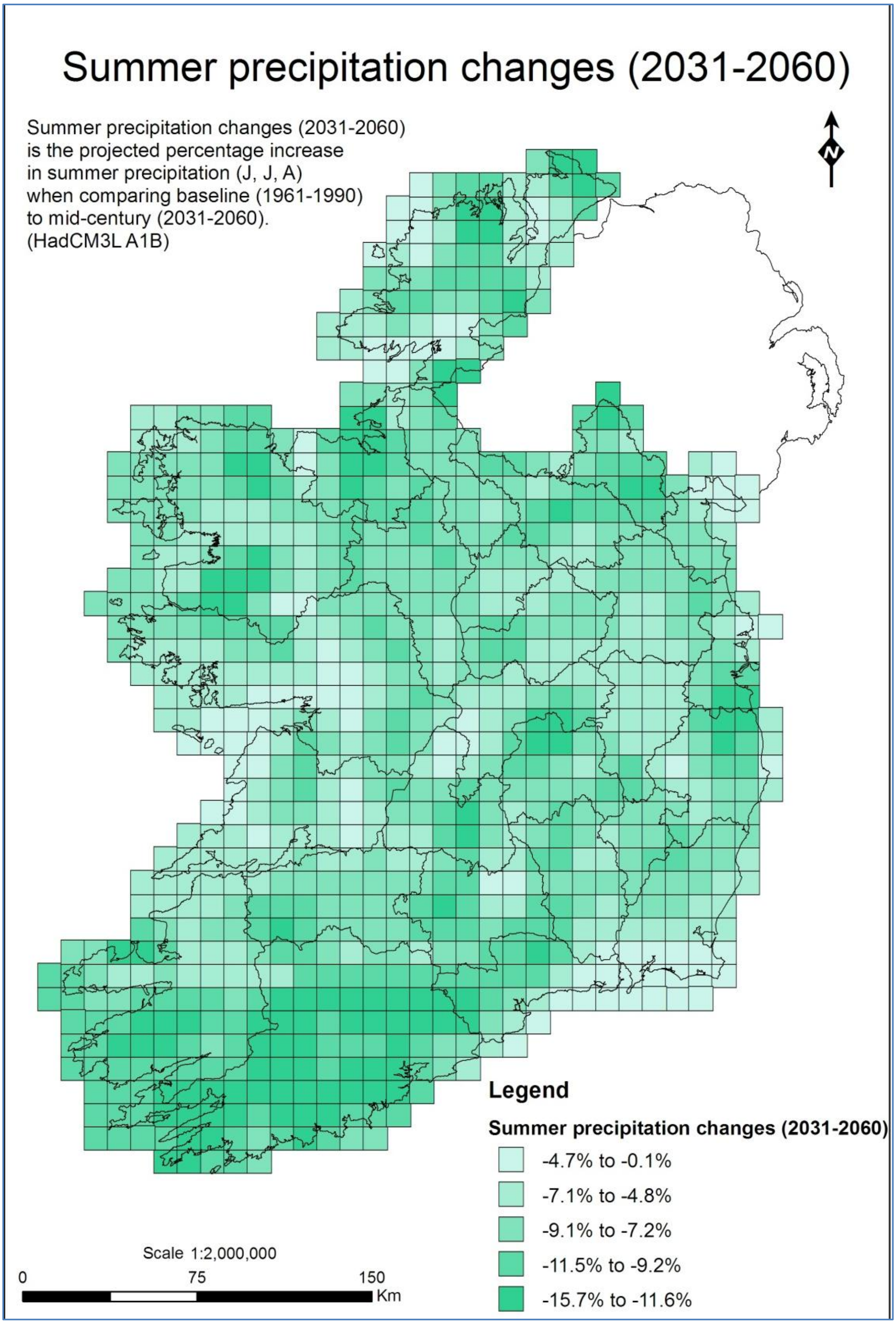
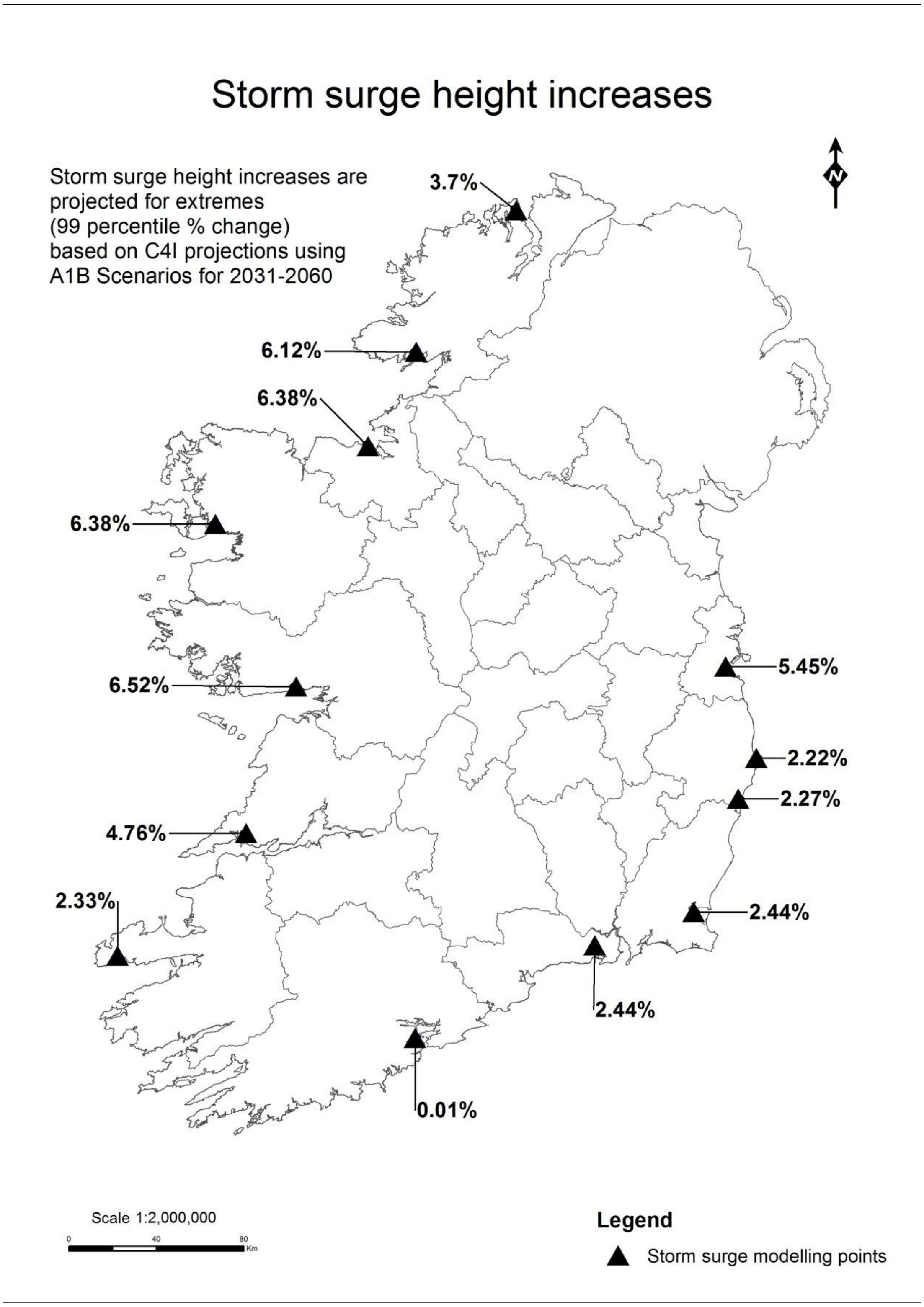
Appendix A. Mapped datasets



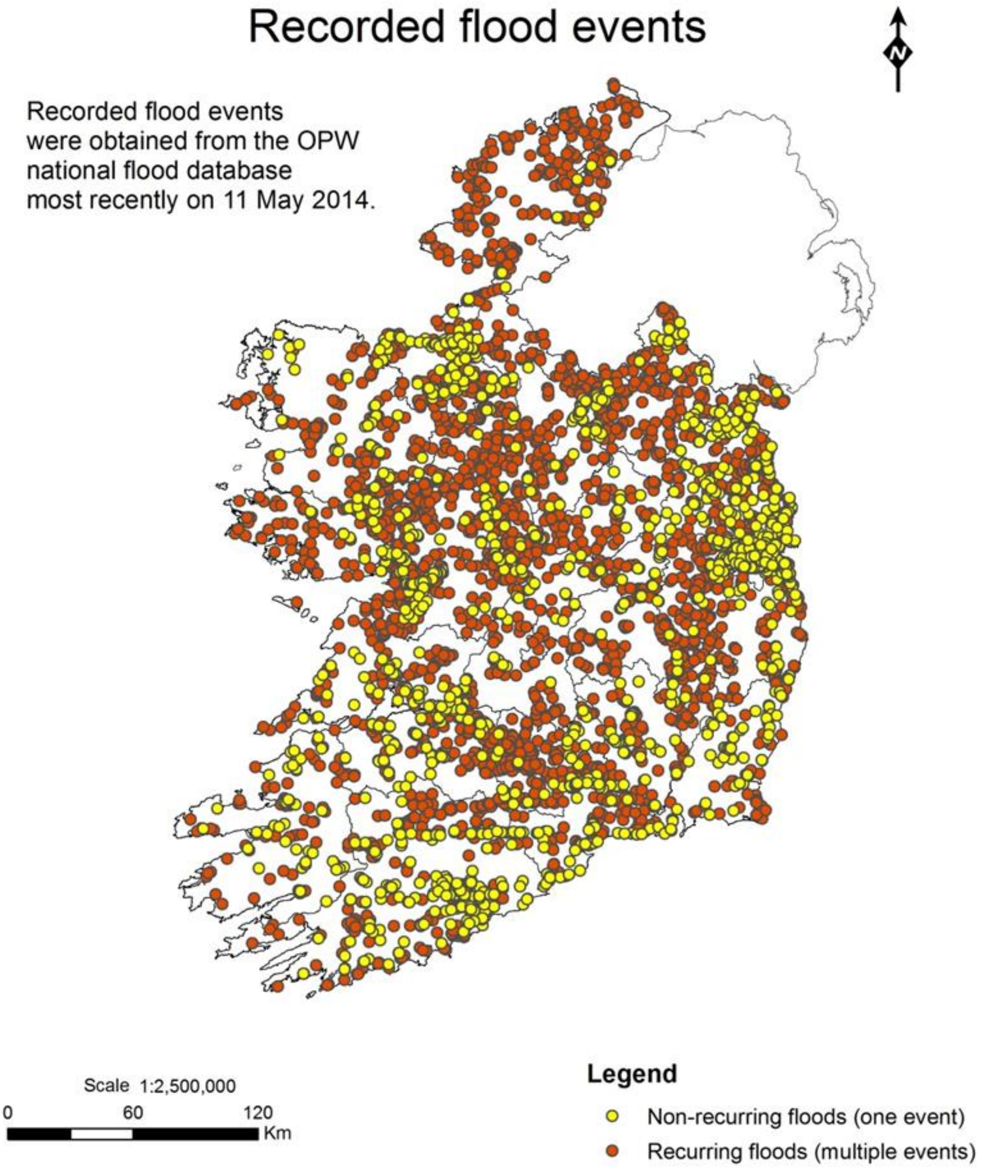
Map A.1 Winter precipitation changes 2031-2060



Map A.2 Summer precipitation changes 2031-2060

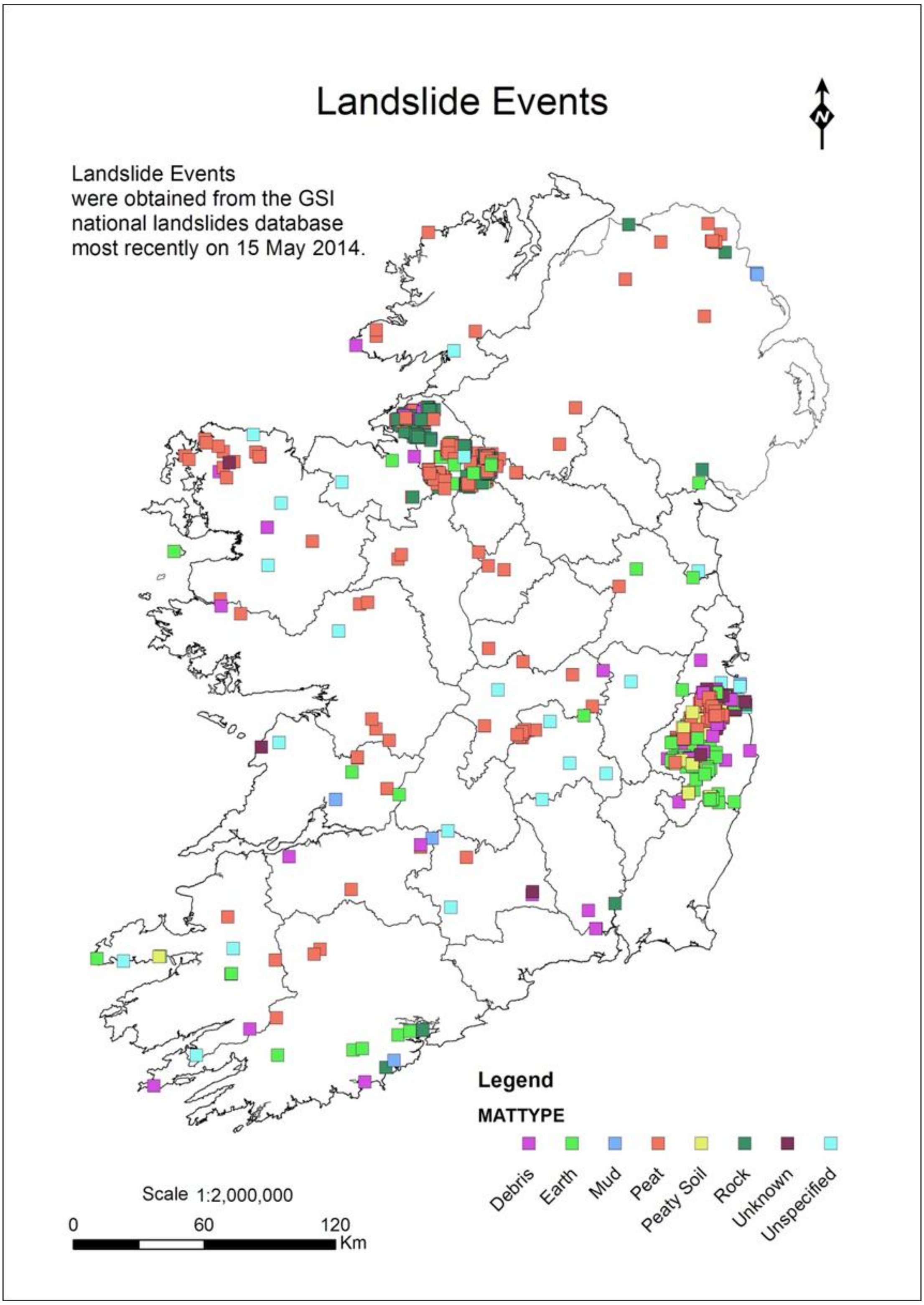


Map A.3 Storm surge height increases projected for extremes (99 percentile change).

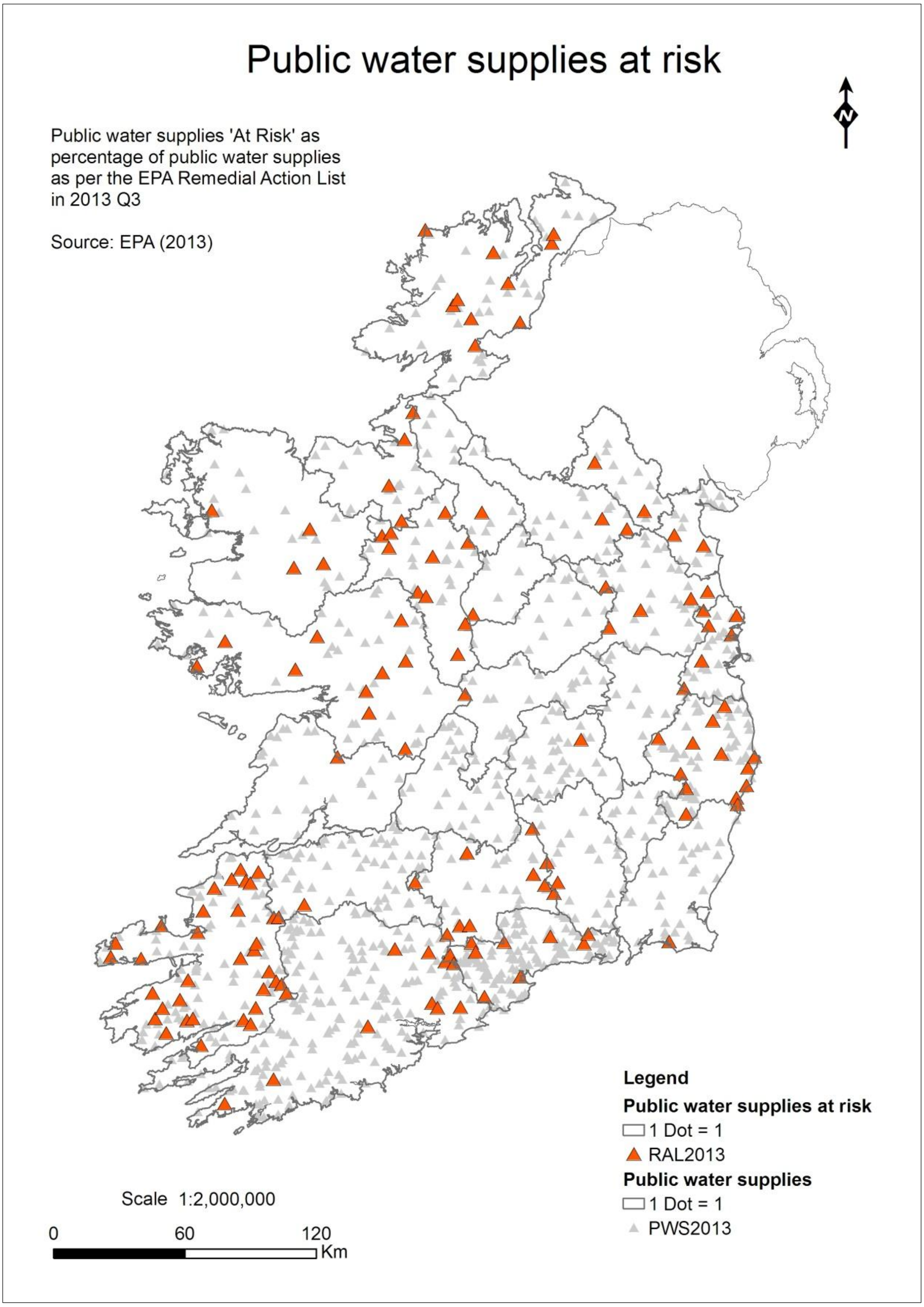


Recorded flood events - OPW national flood database, accessed most recently 11 May 2014														
County	CW	CN	CE	C	DL	D	GW	KY	KE	KK	LS	LM	LK	LD
Floods	89	191	154	503	256	399	515	136	208	127	67	59	246	52
Date	2013	2012	2014	2014	2013	2014	2012	2014	2013	2010	2009	2012	2014	2012
County	LH	MO	MH	MN	OY	RN	SO	TN	TS	WD	WH	WX	WW	
Floods	143	204	226	115	114	237	256	79	267	180	102	125	115	
Date	2014	2011	2013	2014	2013	2012	2012	2013	2013	2010	2012	2014	2013	

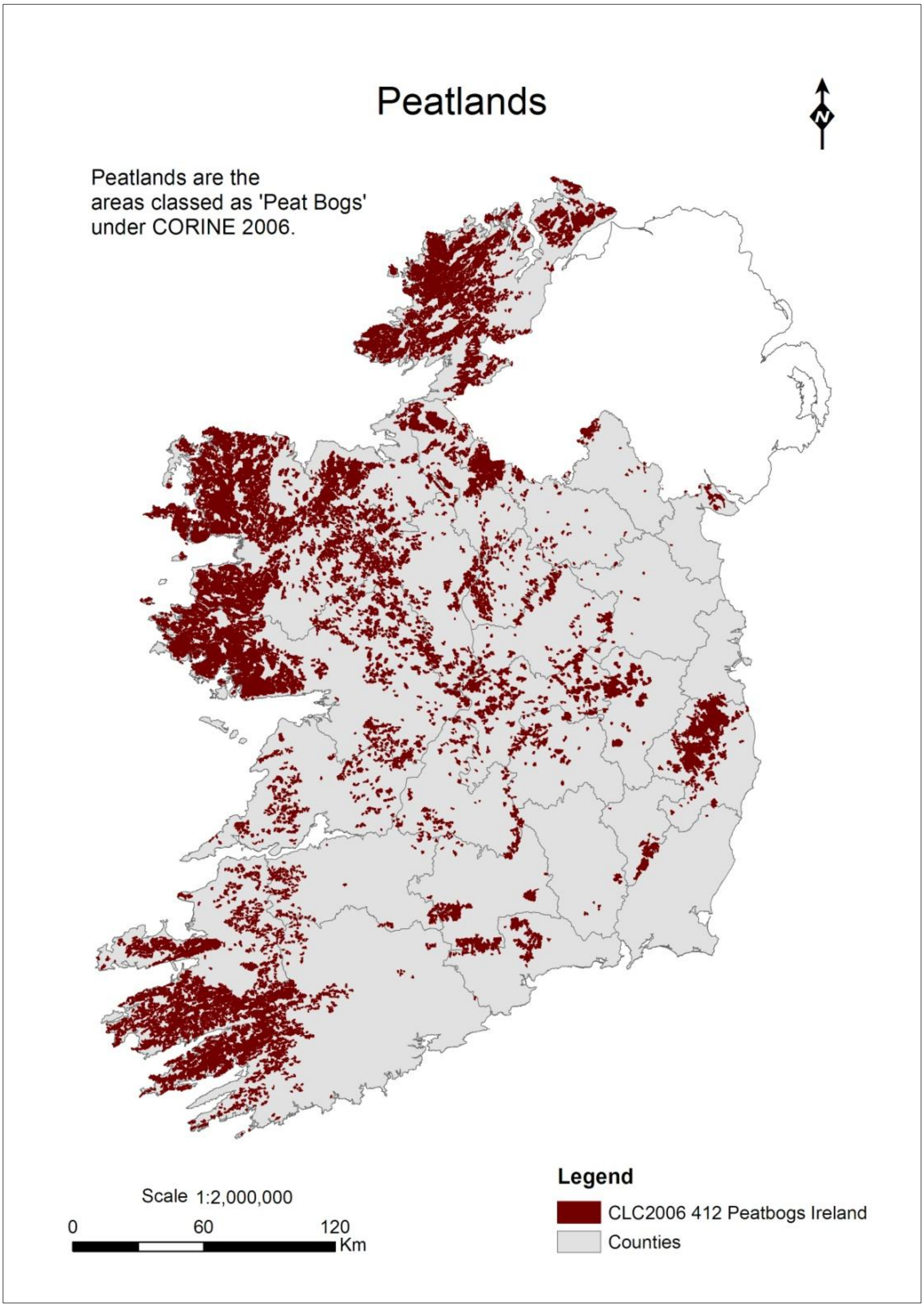
Map A.4 Recorded flood events from the OPW National Flood Database.



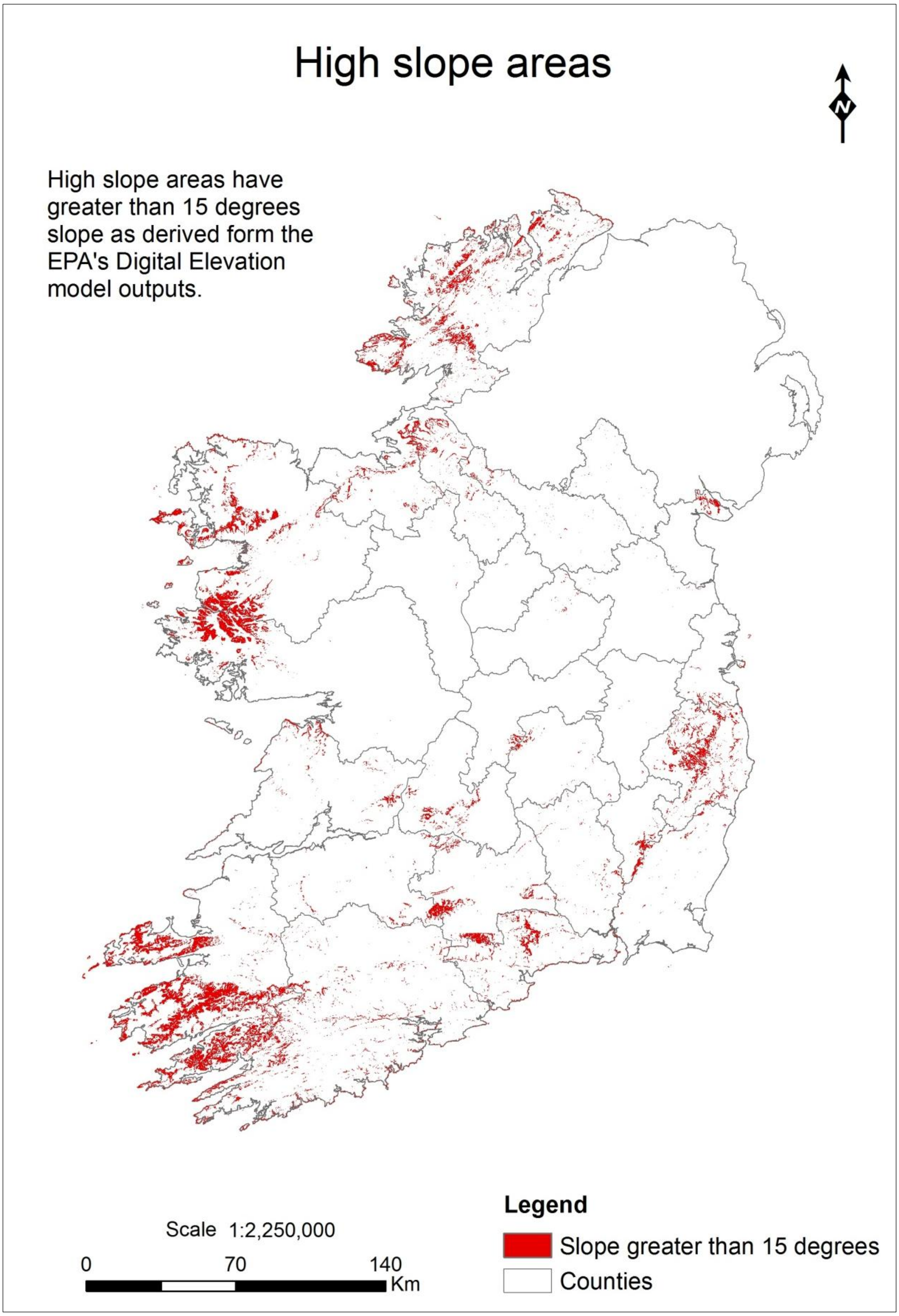
Map A.5 Recorded landslide events in the GSI National Landslide Database.



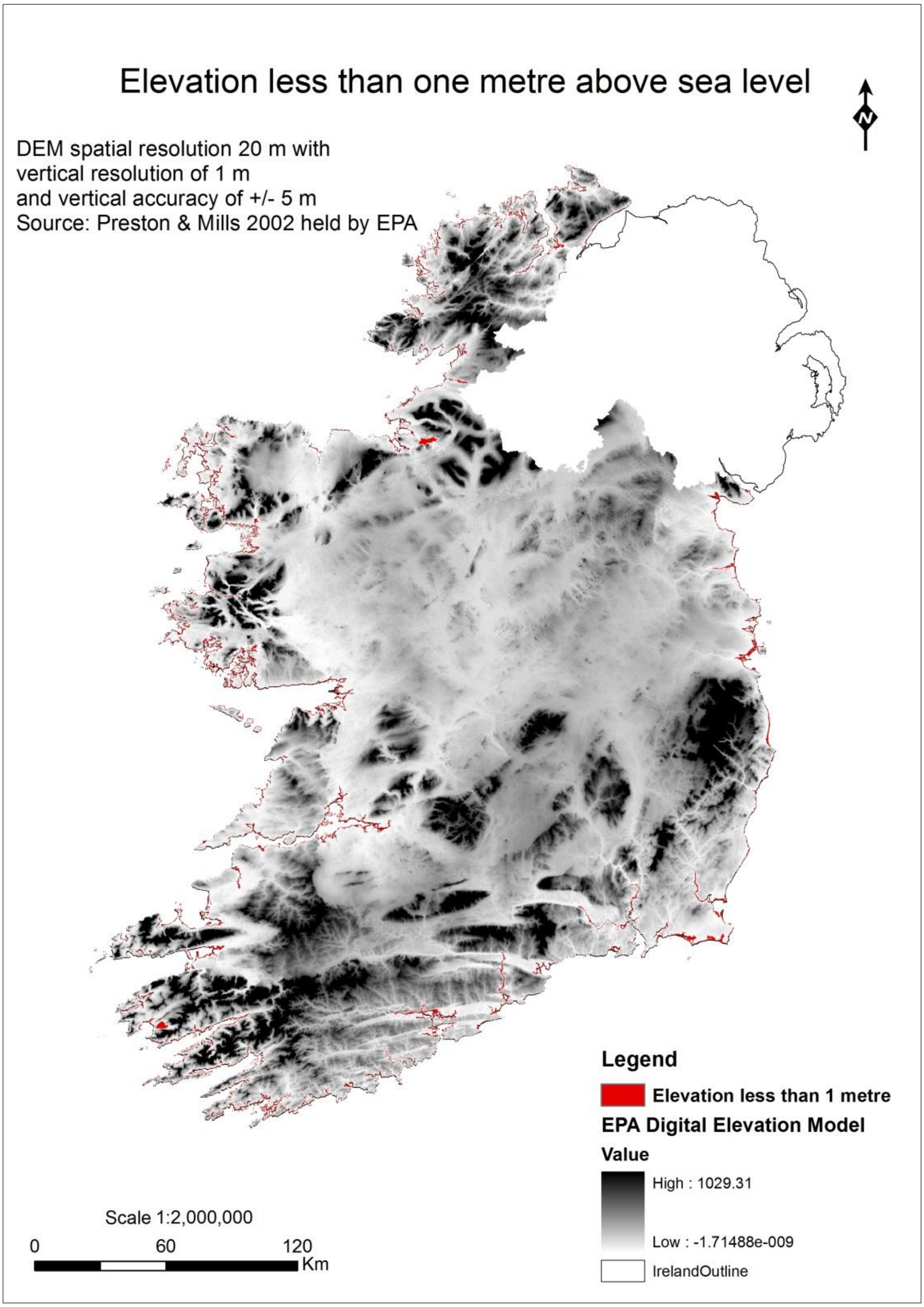
Map A.6 Protected water supplies at risk in the EPA Remedial Action List (2013)



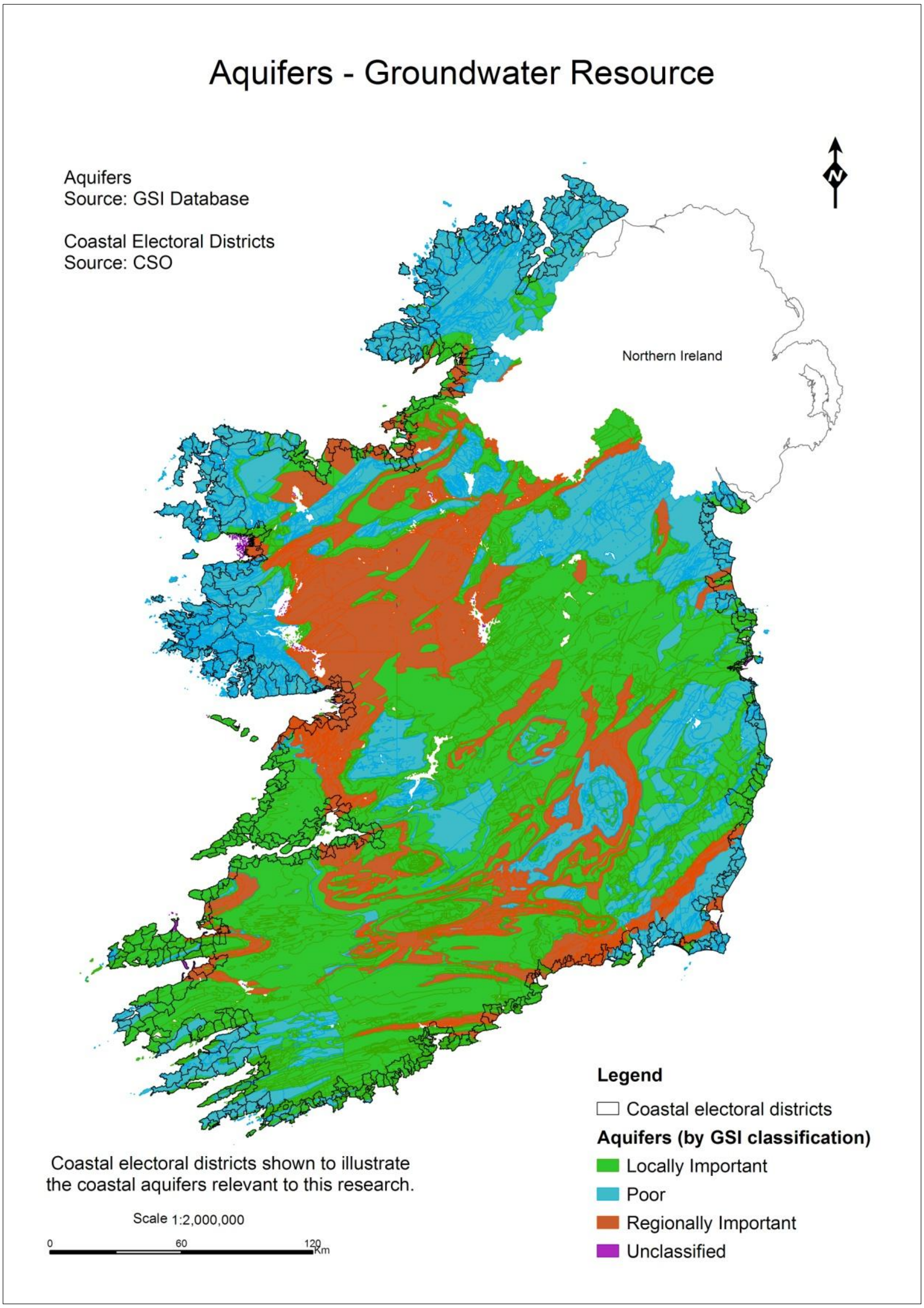
Map A.7 Peatlands in the CORINE Land Cover Update 2006



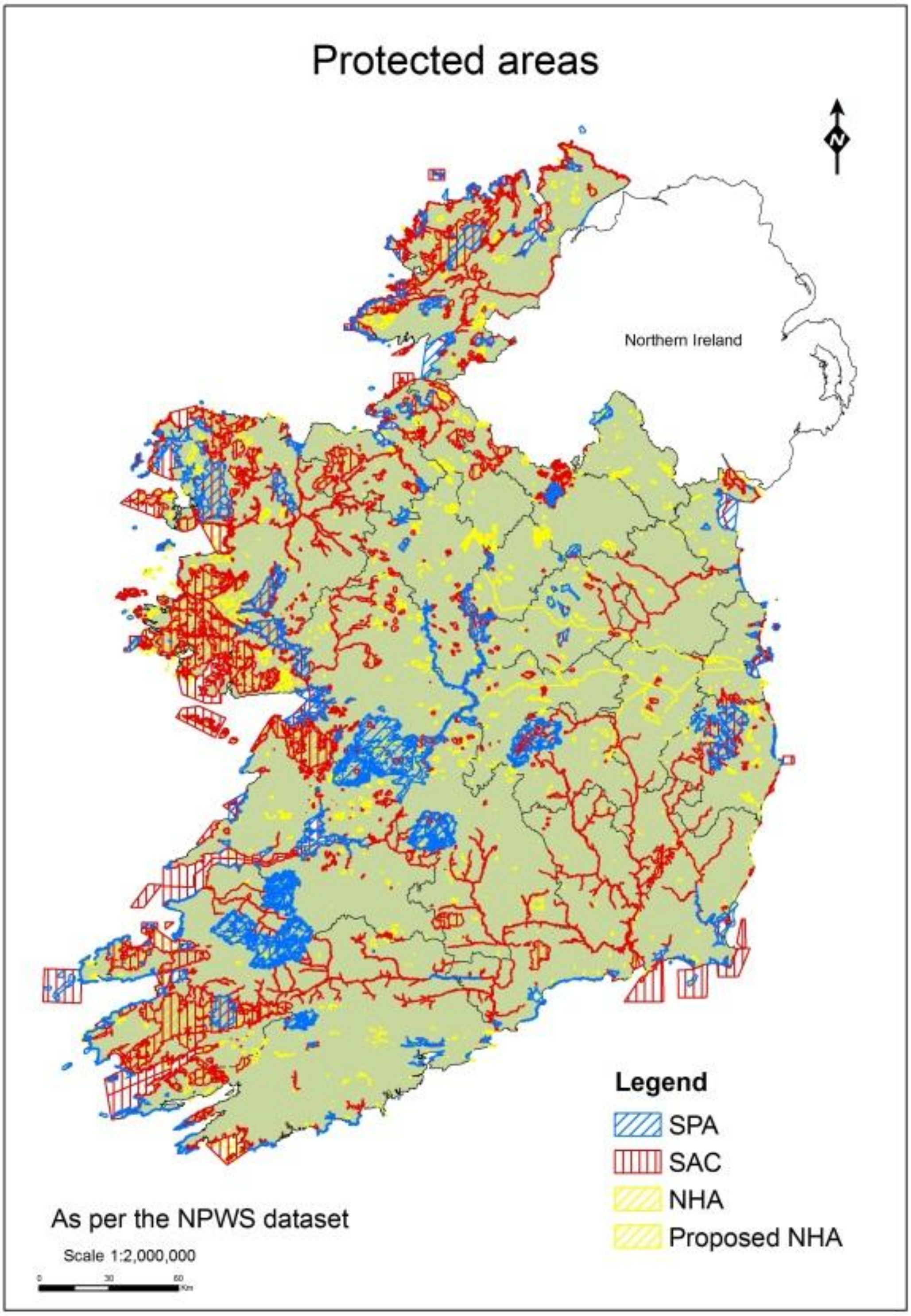
Map A.8 High slope areas with greater than 15 degrees slope



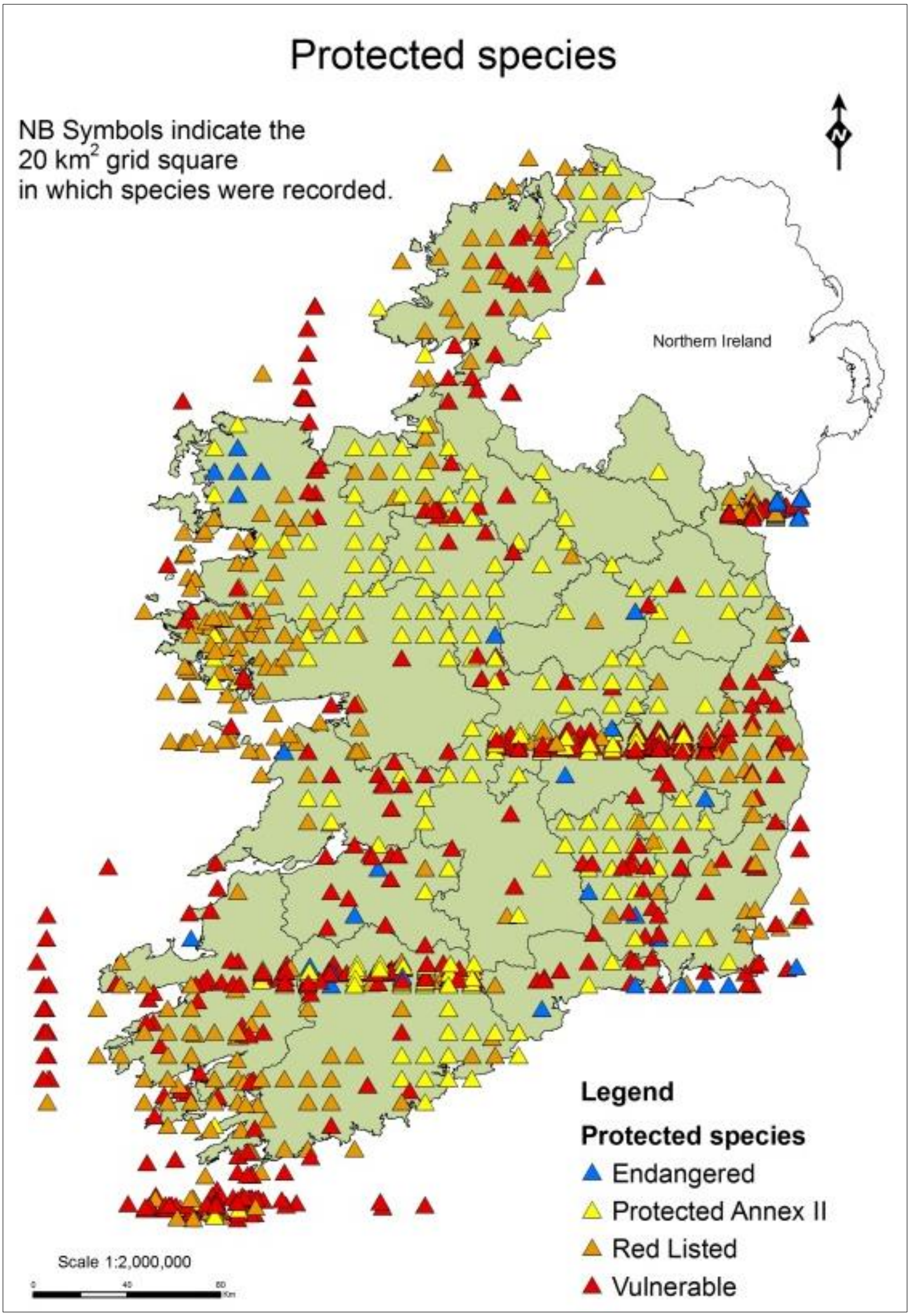
Map A.9 Low lying areas (less than 1 metre above sea level)



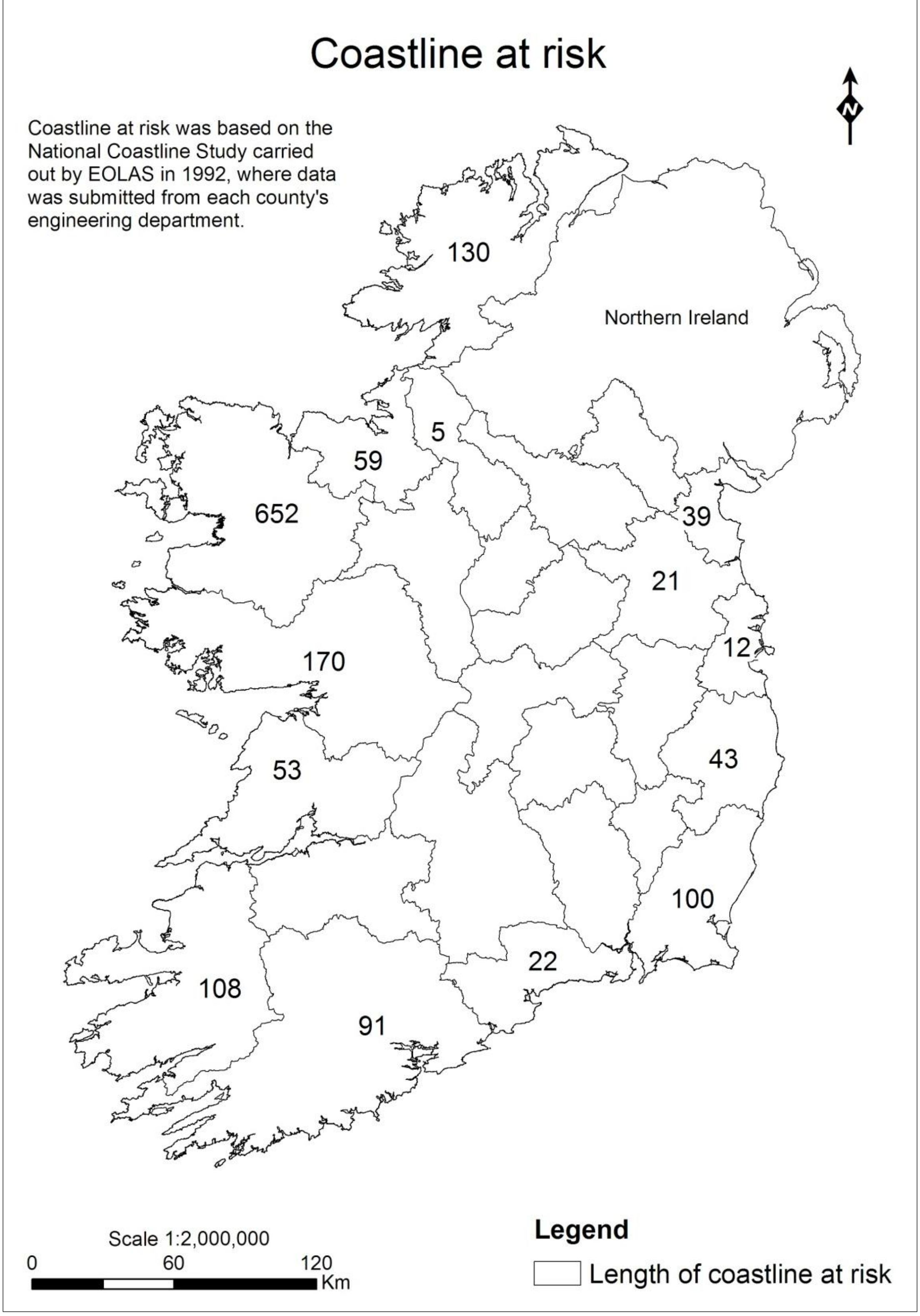
Map A.10 Aquifers from the GSI national database.



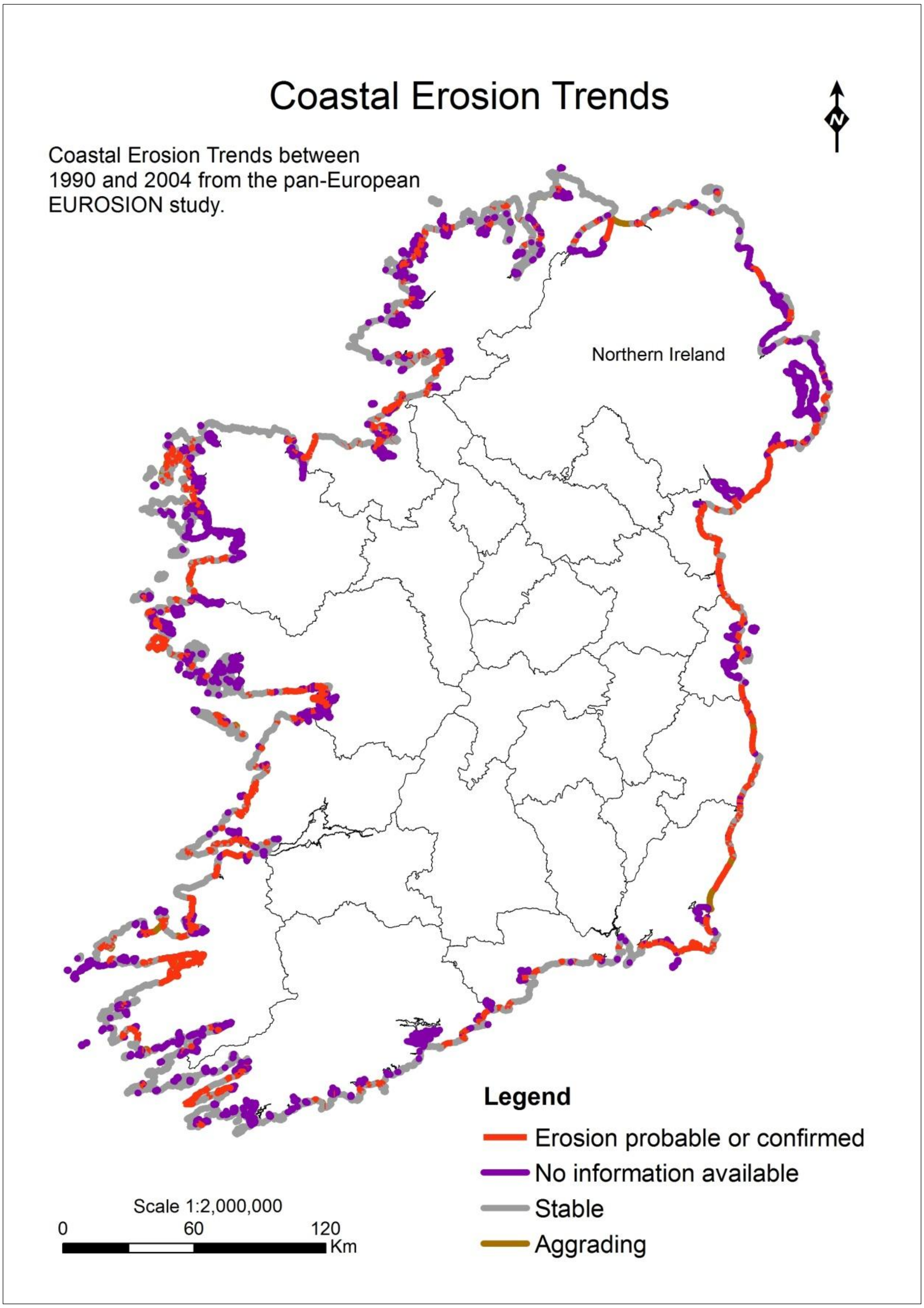
Map A.11 Protected areas including SPAs, SACs, NHAs and pNHAs



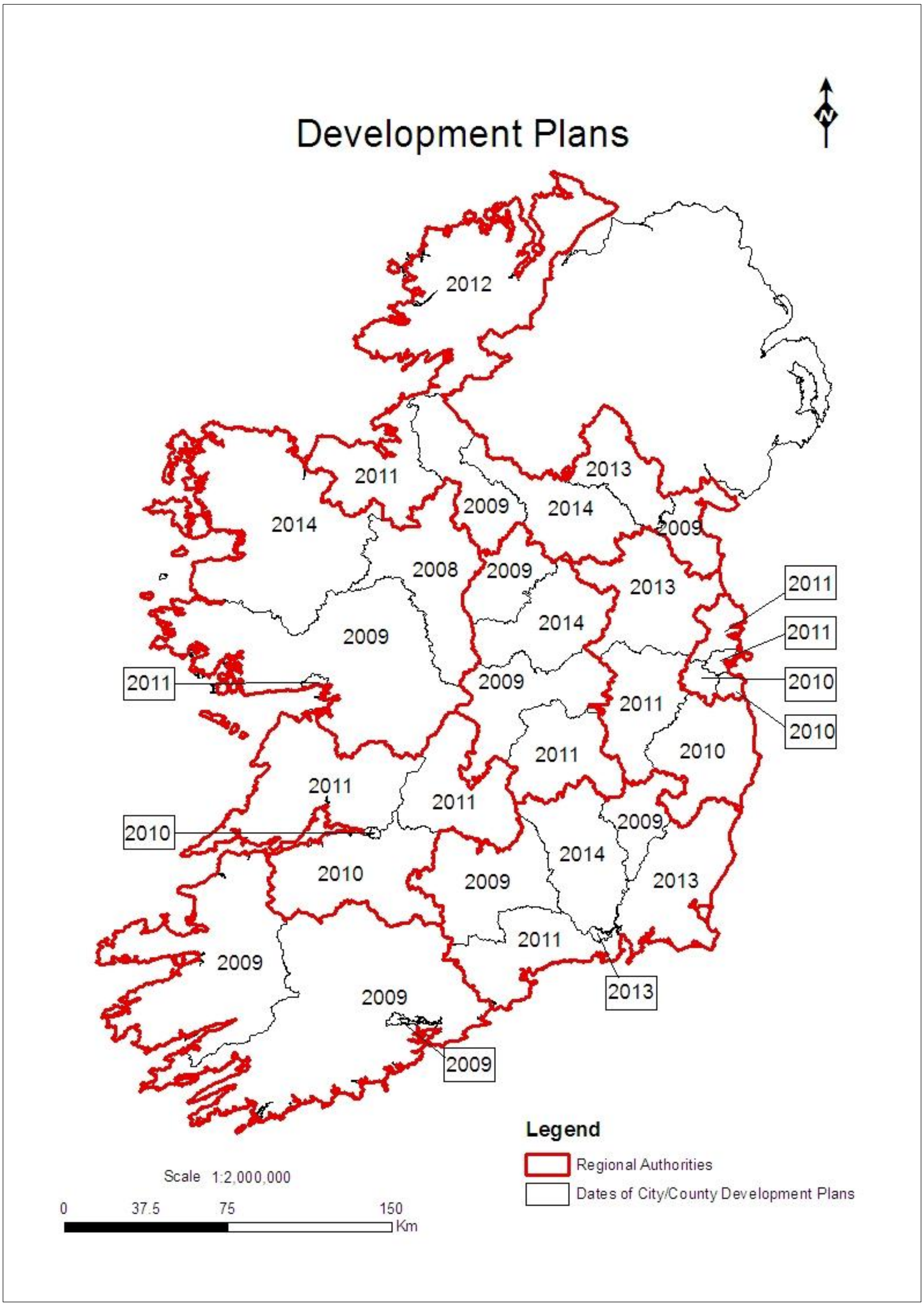
Map A.12 Protected species reported as present in 20 km grid squares



Map A.13 Coastline at Risk (EOLAS, 1992)



Map A.14 Coastal erosion trends per the EUROSION study.



Map A.15 Development Plans adopted by City and County Councils.

Appendix B. Data tables

Table B.1 Flood indicator values listed by county

County	Flood Events[1] Number of Flood Events	Flood Events[1] OPW update 11 May 2014[3]	Increased winter precipitation[2]
Carlow	89	20/Sep/2013	19.5%[4]
Cavan	191	11/Jul/2012	14.9%
Clare	154	20/Sep/2013	13.6%
Cork	503	01/May/2014	15.1%
Donegal	256	20/Sep/2013	10.2%
Dublin	399	13/Mar/2014	17.7%
Galway	515	31/Mar/2012	16.0%
Kerry	136	30/Apr/2014	14.4%
Kildare	208	21/Sep/2013	17.9%
Kilkenny	127	09/Jun/2010	18.5%
Laois	67	17/Nov/2009	17.7%
Leitrim	59	31/Mar/2012	13.5%
Limerick	246	17/Apr/2014	11.6%
Longford	52	13/Jul/2012	15.1%
Louth	143	25/Feb/2014	15.6%
Mayo	204	20/Jan/2011	15.9%
Meath	226	01/Nov/2013	15.8%
Monaghan	115	21/Jan/2014	15.0%
Offaly	114	20/Sep/2013	16.0%
Roscommon	237	24/Jan/2012	14.5%
Sligo	256	12/Dec/2012	12.8%
Tipperary North	79	20/Sep/2013	14.8%
Tipperary South	267	20/Sep/2013	16.6%
Waterford	180	08/Jul/2010	19.0%
Westmeath	102	11/Jul/2012	15.2%
Wexford	125	18/Feb/2014	17.1%
Wicklow	115	21/Sep/2013	18.6%

[1]Flood events are those included in the national floods database maintained by the OPW and include all events up to 11 May 2014. Flood data includes recurring events and non-recurring events; each type of event is counted as '1'.

[2]Precipitation Change Baseline (1961-1990) to Mid-Century (2031-2060). Average of all values contained within county boundaries. Individual 10km2 cells ranged from 4.6-22.4%. County level aggregated values ranged from 10.2-19.5% (Climate model outputs from C4I HadCM3L run with scenario A1B).

[3]Date listed on the OPW website of the most recent update for each county.

[4] Figures are presented in rounded form for readability. All calculations were performed in ArcGIS with a scale of 8 places and precision of 6 places.

Table B.2 Landslide indicator values listed by county

County	County Area km^2	Landslide events to 2014[1]	Peatlands[2]: Peat Area km^2	Peatlands[2]: Peat Area (CLC2006) %	High slope[3]: High slope area km^2	High slope[3]: High slope area %
Carlow	896.63	0	57.03	6.4%	31.18	3.5%
Cavan	1932.03	75	45.30	2.3%	12.02	0.6%
Clare	3236.97	7	198.93	6.1%	50.01	11.4%
Cork	7490.56	14	328.14	4.4%	369.63	4.9%
Donegal	4840.38	6	1797.72	37.1%	341.99	7.1%
Dublin	922.90	41	4.54	0.5%	12.16	1.3%
Galway	6113.93	8	1486.38	24.3%	253.48	4.2%
Kerry	4740.45	11	1829.13	38.6%	800.22	16.9%
Kildare	1695.56	3	77.87	4.6%	1.34	0.1%
Kilkenny	2073.33	0	11.31	0.5%	13.48	0.7%
Laois	1720.35	17	47.60	2.8%	9.75	0.6%
Leitrim	1589.95	124	341.56	21.5%	6862.12	4.3%
Limerick	2699.30	5	153.93	5.7%	57.43	2.1%
Longford	1091.27	3	114.46	10.5%	0.25	0.0%
Louth	827.08	2	25.40	3.1%	19.87	2.4%
Mayo	5560.80	22	2133.72	38.4%	372.44	6.7%
Meath	2341.66	3	8.33	0.4%	1.54	0.1%
Monaghan	1295.46	0	36.93	2.9%	2.27	0.2%
Offaly	2001.30	11	371.23	18.5%	7.67	0.4%
Roscommon	2548.29	6	401.96	15.8%	1.69	0.1%
Sligo	1834.68	78	516.15	28.1%	70.45	3.8%
Tipperary North	2046.80	1	134.72	6.6%	41.03	2.0%
Tipperary South	2258.80	5	102.04	4.5%	107.36	4.8%
Waterford	1857.11	2	90.59	4.9%	105.97	5.7%
Westmeath	1838.90	1	200.90	10.9%	3.39	0.2%
Wexford	2366.18	11	0.51	0.0%	38.89	1.6%
Wicklow	2027.35	428	427.99	21.1%	173.46	8.5%

[1]Landslide events are all events of the *Irish Landslides Database* available at http://spatial.dcenr.gov.ie/GeologicalSurvey/LandslidesViewer/index.html, accessed most recently on 15 May 2014.

[2]Peatlands are all '412 peatbogs' cells from the Corine Land Cover update of 2006. The peat area was extracted for each county, the total peat area totalled, and the peat area as a percentage of the county's land area was calculated.

[3]High slope area is derived from the Digital Elevation Model for each Irish hydrometric area. Each county's land area with a slope greater than 15º was extracted, the total area totalled, and the high slope area as a percentage of the county's land area was calculated.

Table B.3 Public water supply indicator values by county

	Public Water Supplies at Risk			Summer Precipitation (% change)[1]
County	At Risk Water Supplies[2]	Water Supplies[3]	% at risk	Average % increase per county
Carlow	0	14	0%	-8.2%
Cavan	2	17	11%	-8.6%
Clare	0	21	0%	-6.0%
Cork	8[4]	181	4%	-11.3%
Donegal	10	34	29%	-7.7%
Dublin	6[5]	20	27%	-8.1%
Galway	12[6]	39	31%	-6.8%
Kerry	35	72	45%	-9.3%
Kildare	0	11	0%	-6.6%
Kilkenny	2	19	10%	-7.8%
Laois	1	27	3%	-9.3%
Leitrim	1	15	8%	-8.4%
Limerick	1[7]	46	2%	-8.3%
Longford	1	6	14%	-7.8%
Louth	2	15	12%	-5.9%
Mayo	4	24	17%	-8.3%
Meath	5	36	15%	-7.4%
Monaghan	2	10	20%	-10.3%
Offaly	0	23	0%	-7.6%
Roscommon	10	21	48%	-8.4%
Sligo	4	9	29%	-10.2%
Tipperary North	0	29	0%	-8.5%
Tipperary South	9	25	35%	-8.7%
Waterford	11[8]	112	10%	-7.4%
Westmeath	0	15	0%	-7.8%
Wexford	1	28	3%	-5.1%
Wicklow	13	54	23%	-8.2%

[1] Summer precipitation change comparing baseline (1961-1990) to mid-century (2031-2060) outputs modelled with HadCM3L A1B. (C4I project)
[2] Public water supplies at risk in *EPA Remedial Action List 2013 Q3* (EPA, 2013)
[3] Public water supplies in *The Provision and Quality of Drinking Water in Ireland: A Report for the Year 2012* (Hayes et al., 2013), Appendix I.
[4] Cork RAL: Cork City 1 of 1, County Cork 7 of 180
[5] Dublin RAL: Dublin City 3 of 6, DLR 3 of 8, Fingal 0 of 2, South Dublin 0 of 4
[6] Galway RAL: Galway City 0 of 1, County Galway 12 of 38
[7] Limerick RAL: Limerick City 0 of 1, County Limerick 1 of 45
[8] Waterford RAL: Waterford City 0 of 2, County Waterford 11 of 110

Table B.4 Biodiversity indicators values by county

Biodiversity Indicators				
	Protected sites			Protected species[3]
	Protected sites (km^2)[1]	County Land (km^2)[2]	% protected land	
Carlow	48	897	5%	21
Cavan	184	1932	10%	6
Clare	1648	3237	51%	25
Cork	910	7491	12%	37
Donegal	1965	4840	41%	23
Dublin	28	923	3%	21
Galway	2793	6114	46%	31
Kerry	2777	4740	59%	31
Kildare	59	1696	3%	22
Kilkenny	67	2073	3%	25
Laois	92	1720	5%	17
Leitrim	245	1590	15%	10
Limerick	457	2699	17%	15
Longford	146	1091	13%	9
Louth	252	827	30%	15
Mayo	2575	5561	46%	25
Meath	59	2342	3%	20
Monaghan	68	1295	5%	7
Offaly	199	2001	10%	17
Roscommon	322	2548	13%	14
Sligo	502	1835	27%	14
Tipperary North	386	2047	19%	15
Tipperary South	128	2259	6%	14
Waterford	259	1857	14%	22
Westmeath	242	1839	13%	16
Wexford	818	2366	35%	35
Wicklow	590	2027	29%	33

[1] Protected sites – from Designated Site Data accessed through the NPWS map-viewer [online]. Available at: http://www.npws.ie/mapsanddata/designatedsitedata, accessed 5 April 2012.

[2] County land area from Census 2011 Administrative Counties which contains Ordnance Survey Ireland data © OSi 2012 [online]. Available at: http://census.cso.ie/censusasp/saps/boundaries/ED_SA%20Disclaimer1.htm, accessed 24 August 2013.

[3] Protected species - from Designated Site Data accessed through the NPWS map-viewer [online]. Available at: http://www.npws.ie/mapsanddata/designatedsitedata, accessed 5 April 2012.

Table B.5 Coastal erosion indicators values by county

Coastal Erosion Indicators values					
County[1]	Coastline at risk (km) [2]			Erosion trends (km)[3]	
	At Risk	Coastline length		Erosion probable or confirmed	Coastline length
Clare	53	366		57	300
Cork	91	1,118		122	1,050
Donegal	130	650		71	1,029
Dublin	12	99		37	162
Galway	170	689		110	882
Kerry	108	684		180	899
Leitrim	5	5		0	7
Limerick	30[4]	95		n/a	n/a
Louth	39	90		48	93
Mayo	652	1,168		84	827
Meath	21	21		10	11
Sligo	59	195		49	209
Waterford	22	170		19	148
Wexford	100	264		88	213
Wicklow	43	61		47	84

[1]These studies excluded inland counties: Carlow, Cavan, Kildare, Kilkenny, Laois, Monaghan, Offaly, Roscommon, Tipperary North, Tipperary South, and Westmeath.

[2]Coastline at risk are the coastline lengths identified at risk by county councils in the 1992 EOLAS study initiated by the National Coastal Erosion Committee.

[3]Erosion trends are the coastline lengths identified with probable or confirmed erosion between 1990 and 2004 based on the 2004 EUROSION study.

[4] Limerick County identified coastline at risk of 30km within the EOLAS study. This was not used in this study because no corresponding identification was made in the 2004 EUROSION study. Of note, the EUROSION study excluded estuaries.

Table B.6 Sea level rise indicators values by county

Sea Level Rise Indicators			
	Elevation < 1 metre[1] (area in km^2)	Storm surge increase[2]	Coastal Aquifers[3] (area in km^2)
Carlow	n/a[4]	n/a	n/a
Cavan	n/a	n/a	n/a
Clare	18	6.52%	903
Cork	34	0.01%	976
Donegal	27	3.70%	371
Dublin	15	5.45%	149
Galway	24	6.52%	262
Kerry	39	2.33%	1508
Kildare	n/a	n/a	n/a
Kilkenny	n/a	n/a	n/a
Laois	n/a	n/a	n/a
Leitrim	2	6.12%	90
Limerick	n/a	n/a	n/a
Louth	11	5.45%	63
Mayo	20	6.38%	326
Meath	2	5.45%	62
Monaghan	n/a	n/a	n/a
Offaly	n/a	n/a	n/a
Roscommon	n/a	n/a	n/a
Sligo	19	6.38%	422
Tipperary North	n/a	n/a	n/a
Tipperary South	n/a	n/a	n/a
Waterford	16	2.44%	300
Westmeath	n/a	n/a	n/a
Wexford	30	2.44%	171
Wicklow	7	2.22%	169

[1]Elevation – Low-lying areas in coastal counties (EPA DEM)

[2]Storm surge – % increase in height comparing baseline to 2031-2060 (C4I)

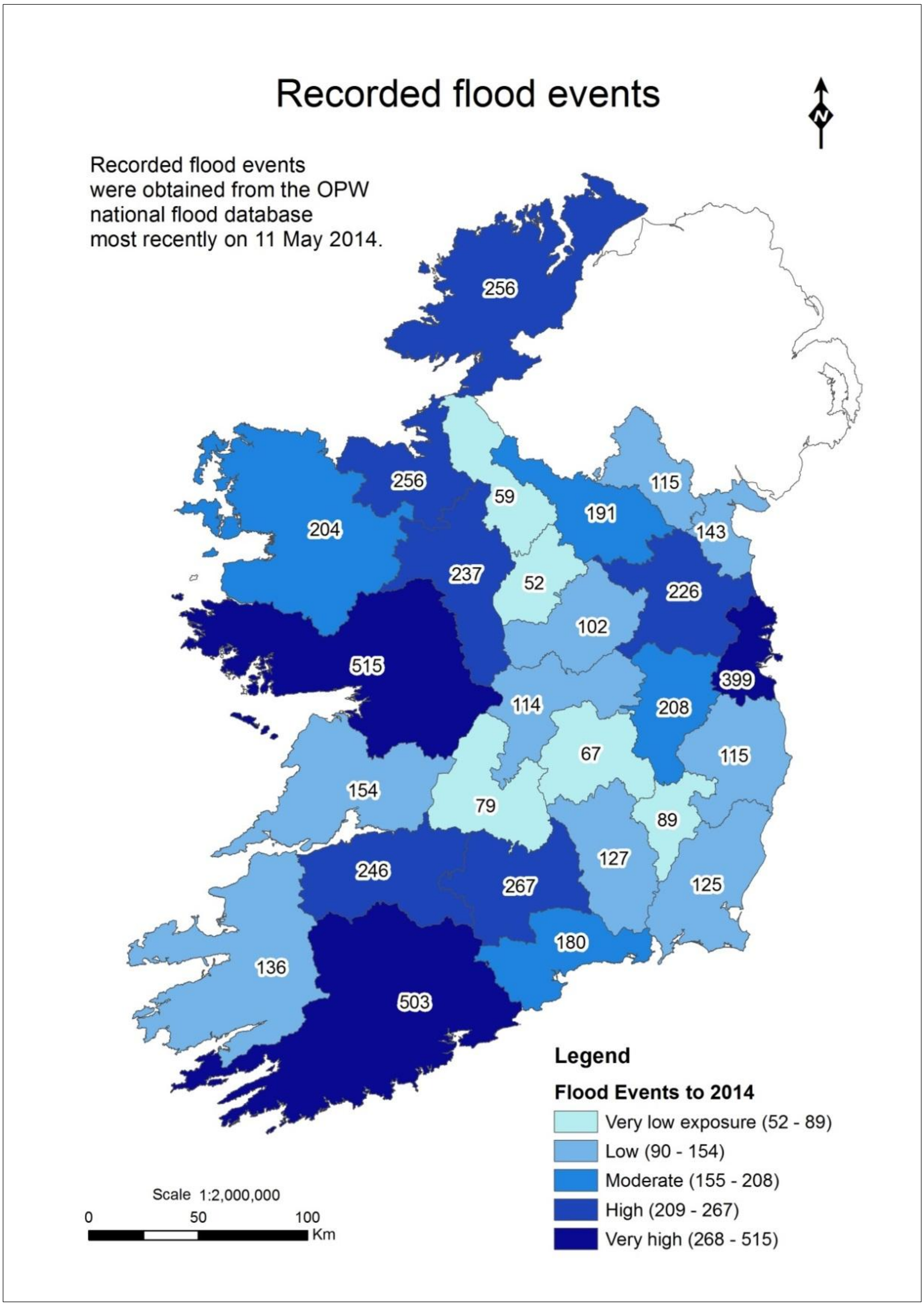
[3]Coastal Aquifers - Regionally and locally Important in coastal EDs (GSI)

[4]n/a – classified as non-coastal counties

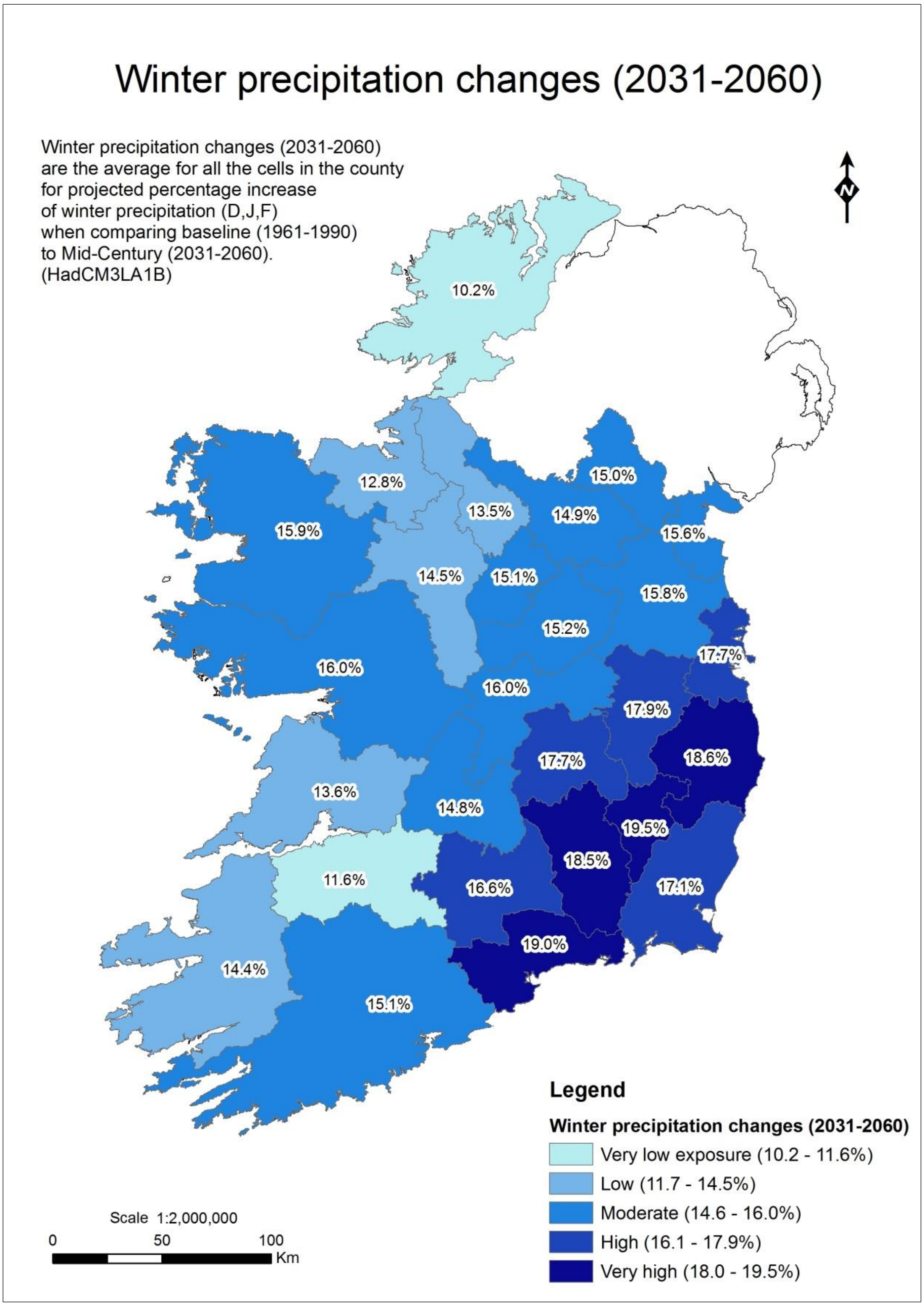
Table B.7 Adaptive capacity indicators values by county

	Adaptive Capacity Indicators			
	Development plans[1]		Climate Change Strategies[2]	2012 Forward planning staff[3]
	No. measures	Date		
Carlow	7	2009	3	6.0
Cavan	9	2014	5	2.2
Clare	9	2011	1	16.2
Cork City	8	2009	2	12.8
Cork County	6	2009	3	24.6
Donegal	7	2012	4	8.5
Dublin City	8	2011	1	36.5
Dún Laoghaire-Rathdown	7	2010	1	15.0
Fingal	9	2011	2	25.0
Galway City	8	2011	3	4.7
Galway County	4	2009	3	9.3
Kerry	7	2009	4	8.0
Kildare	7	2011	4	11.2
Kilkenny	8	2014	2	3.0
Laois	8	2011	1	4.6
Leitrim	5	2009	5	2.0
Limerick City	9	2010	1	1.0
Limerick County	5	2010	1	7.5
Longford	6	2009	3	3.0
Louth	7	2009	4	9.5
Mayo	8	2014	5	5.6
Meath	9	2013	1	13.8
Monaghan	7	2013	5	4.0
Offaly	5	2009	1	5.0
Roscommon	3	2008	1	5.7
Sligo	7	2011	3	2.0
South Dublin	8	2010	1	28.5
Tipperary North	7	2011	1	5.4
Tipperary South	6	2009	1	7.7
Waterford City	5	2013	1	1.8
Waterford County	7	2011	1	2.8
Westmeath	8	2008	4	5.5
Wexford	9	2013	3	6.9
Wicklow	10	2010	3	5.1
[1] Development plans – Number of sectors with added measures in plans as of 6/2014.				
[2] Climate change strategies values are: 1 published draft or strategy, 2 completed unpublished strategy, 3 strategy in process, 4 stated objective to prepare a strategy, and 5 no current plans to prepare a strategy.				
[3] Forward Planning Staff are 2012 forward planning staff as per DECLG site, http://www.environ.ie/en/Publications/StatisticsandRegularPublications/PlanningStatistics/, accessed 13 April 2014.				

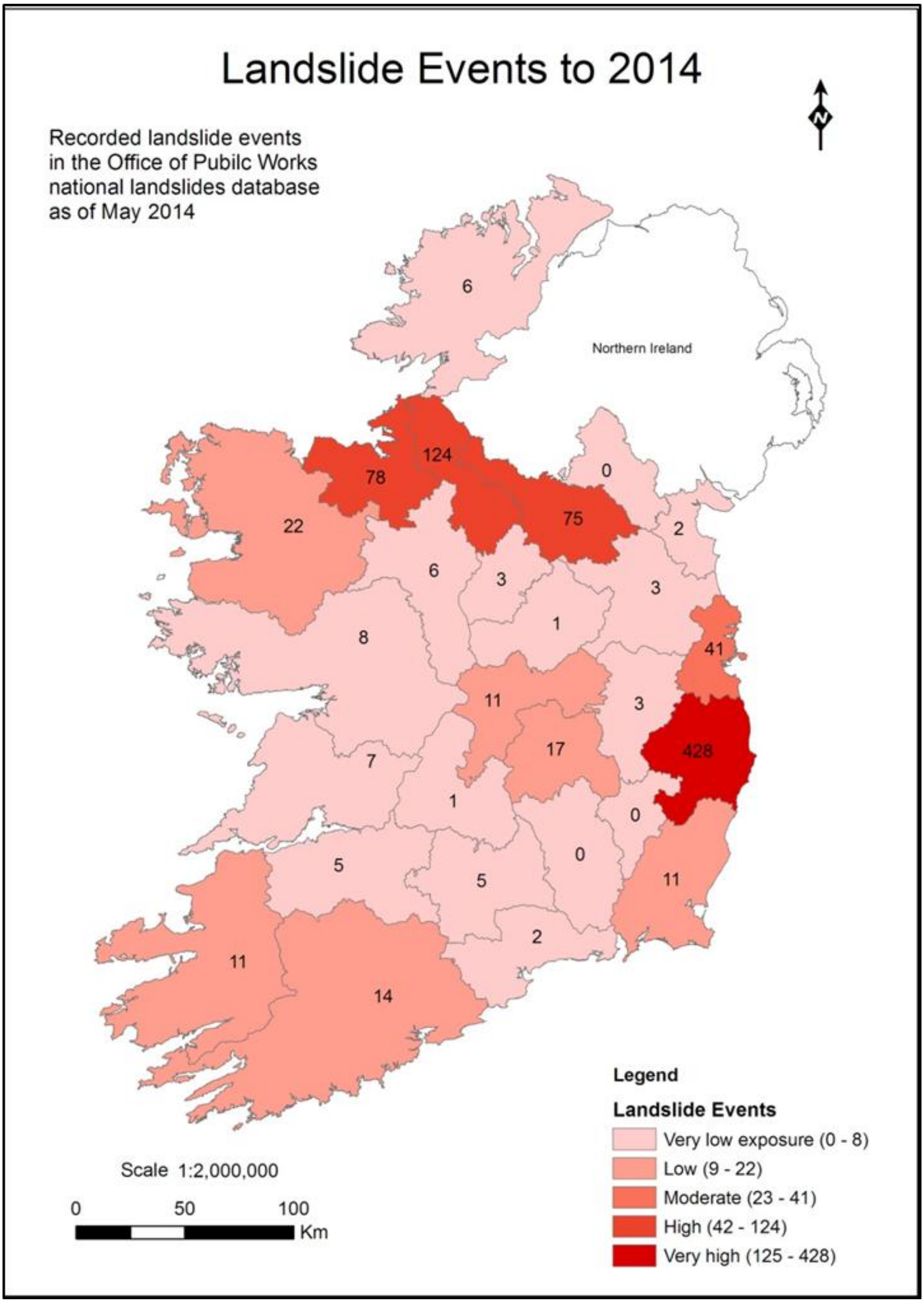
Appendix C. Vulnerability Assessment Maps



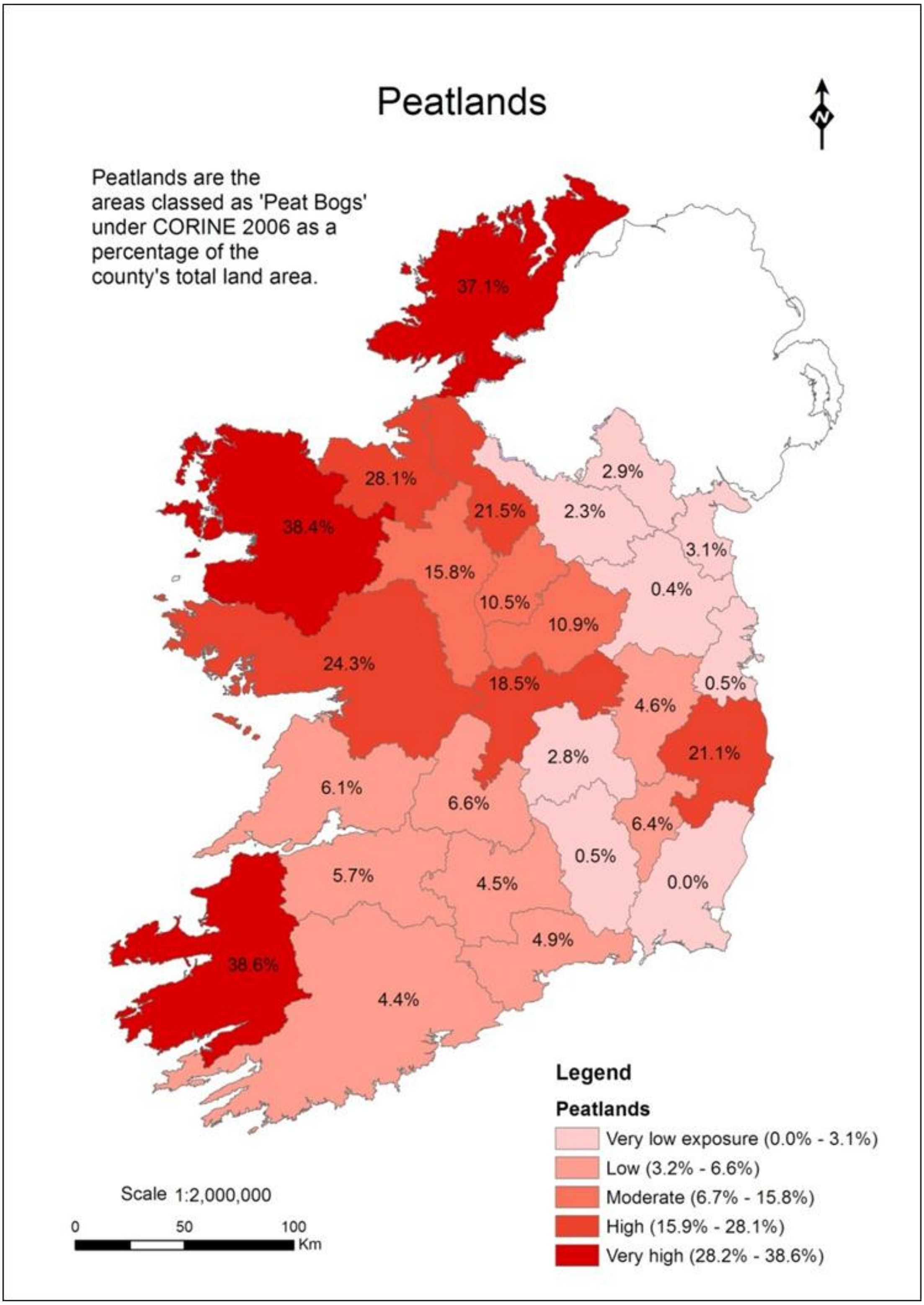
Map C.1 Recorded flood events relative ranking



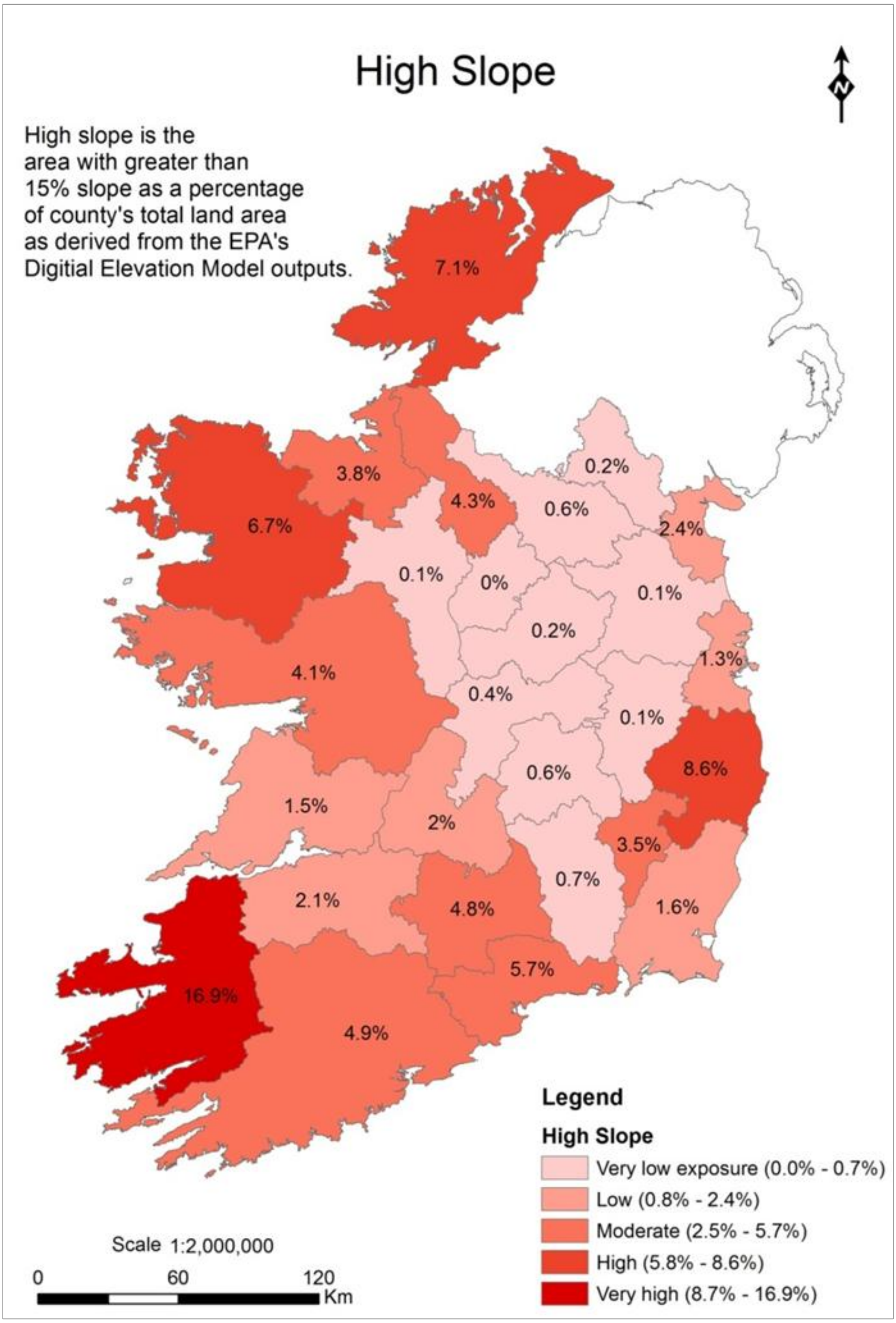
Map C.2 Winter precipitation changes relative ranking



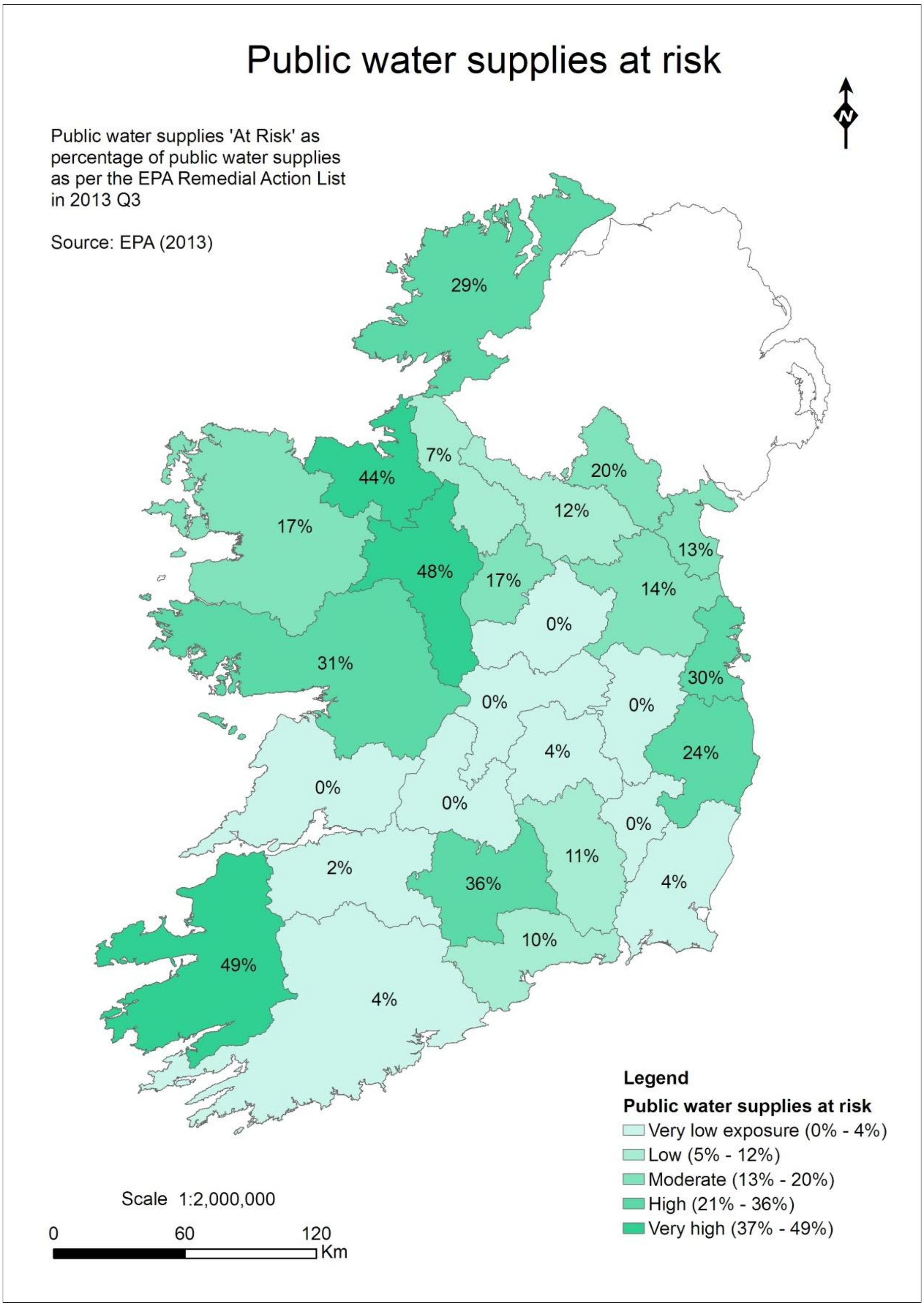
Map C.3 Landslide events relative ranking



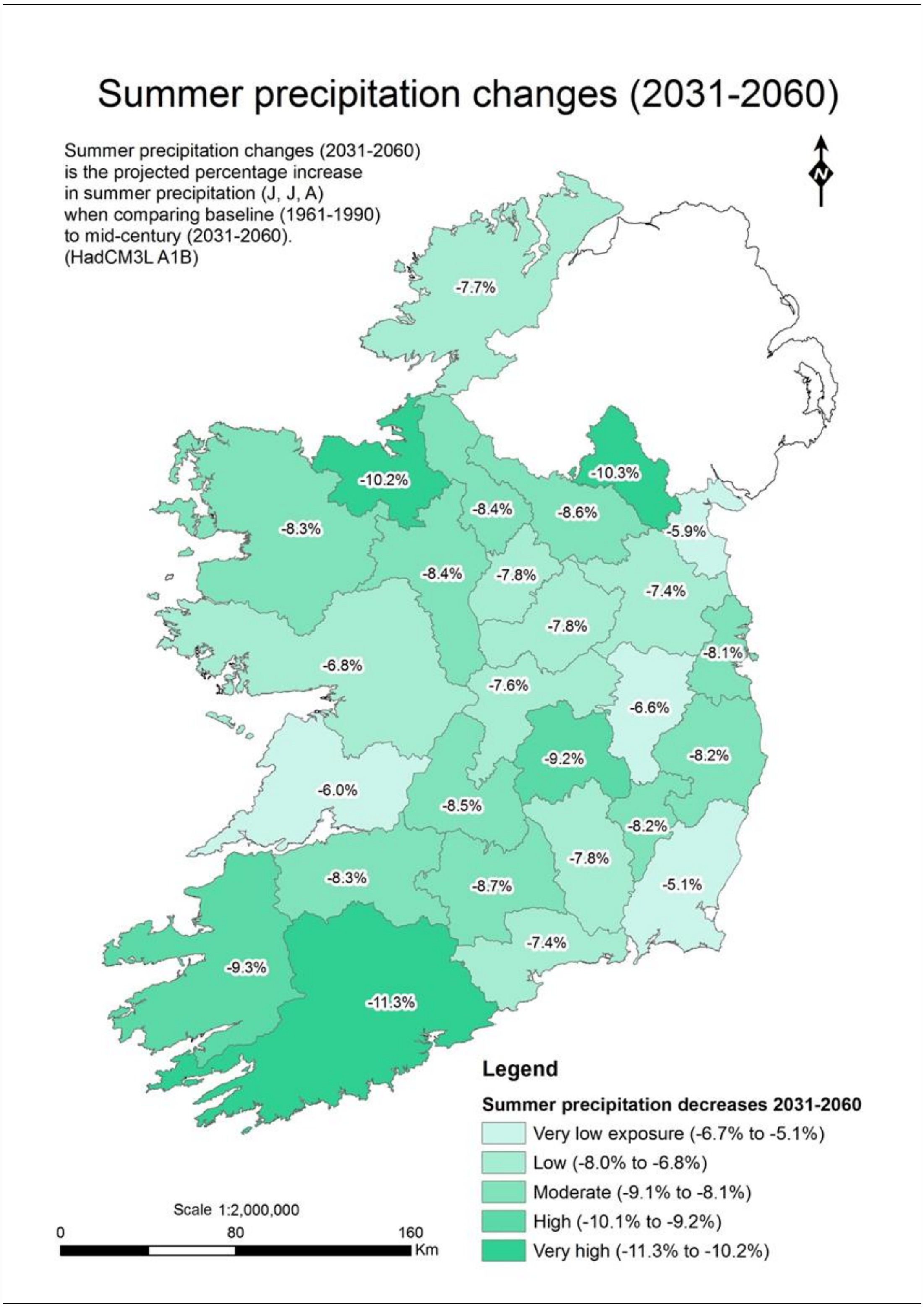
Map C.4 Peatlands relative ranking



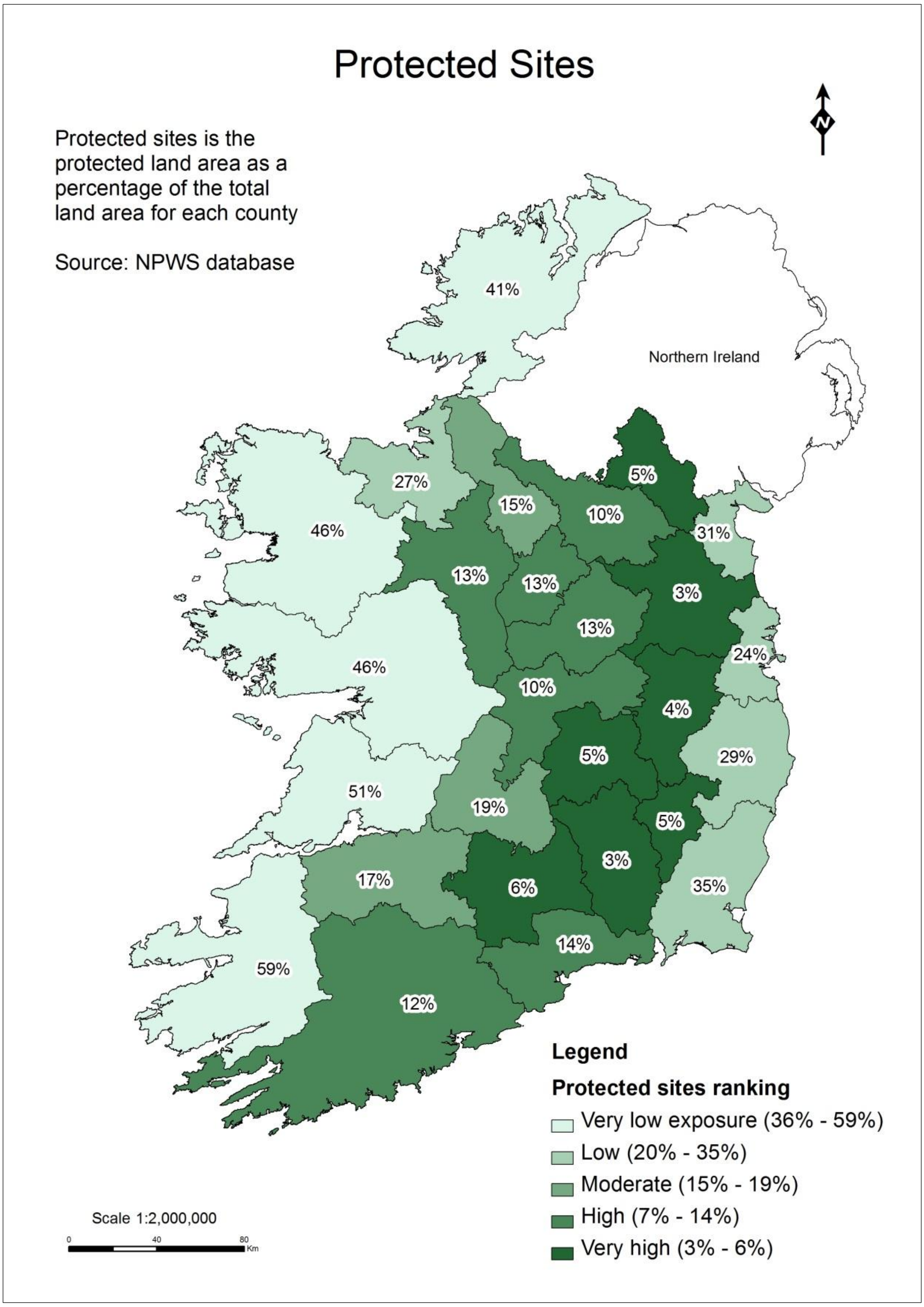
Map C.5 High slope areas relative ranking



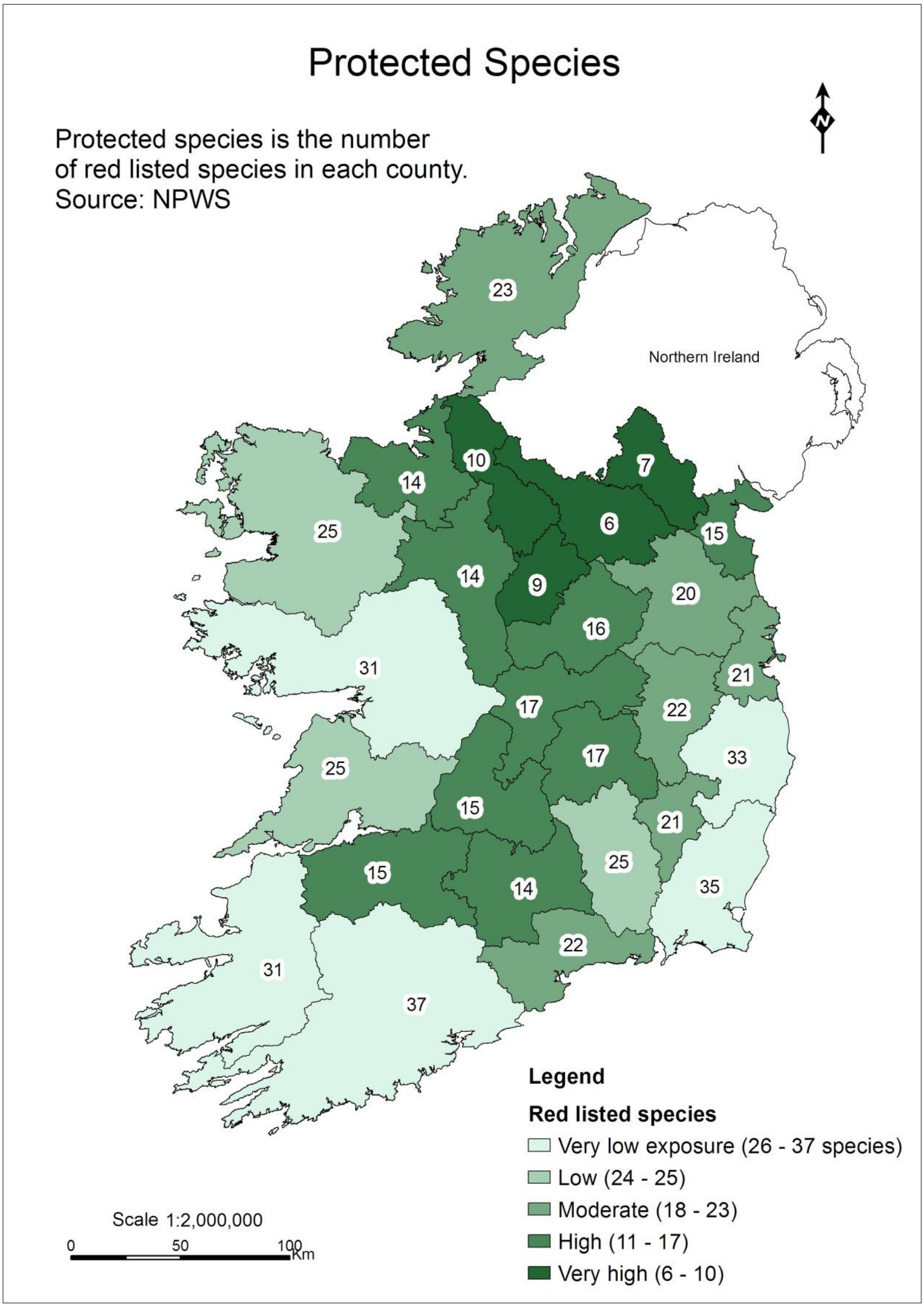
Map C.6 Public water supplies at risk - relative ranking



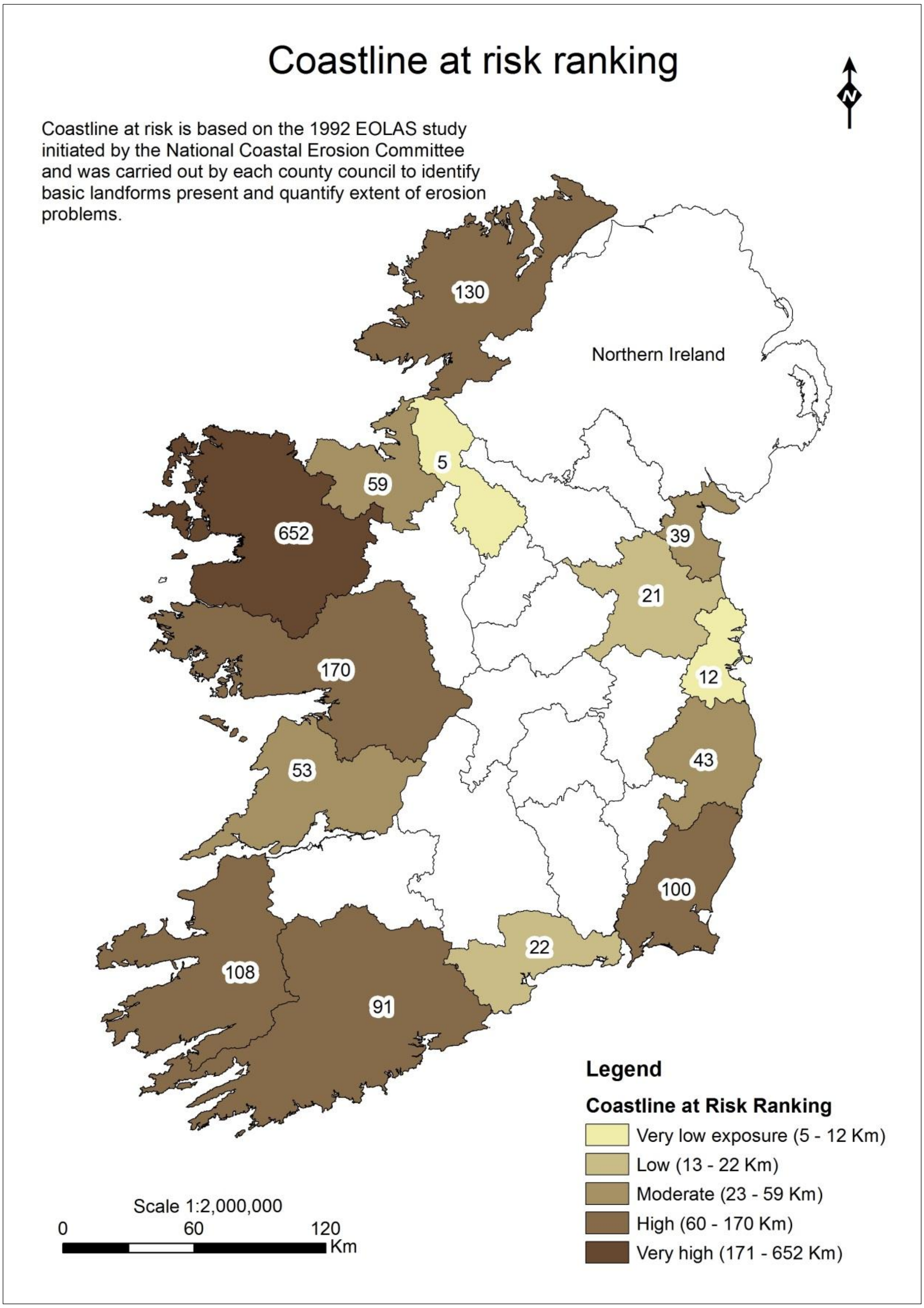
Map C.7 Summer precipitation changes relative ranking



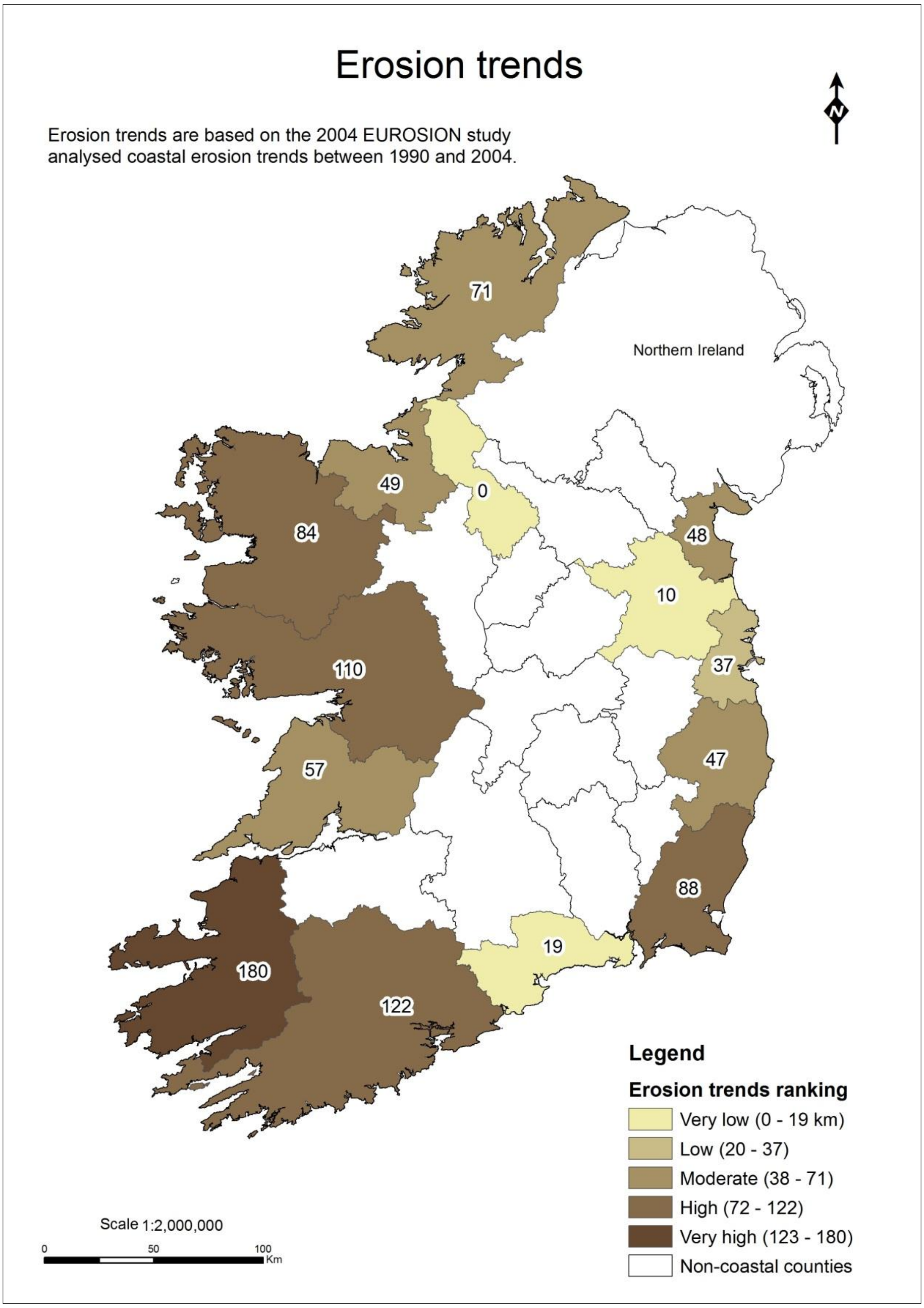
Map C.8 Protected sites relative ranking



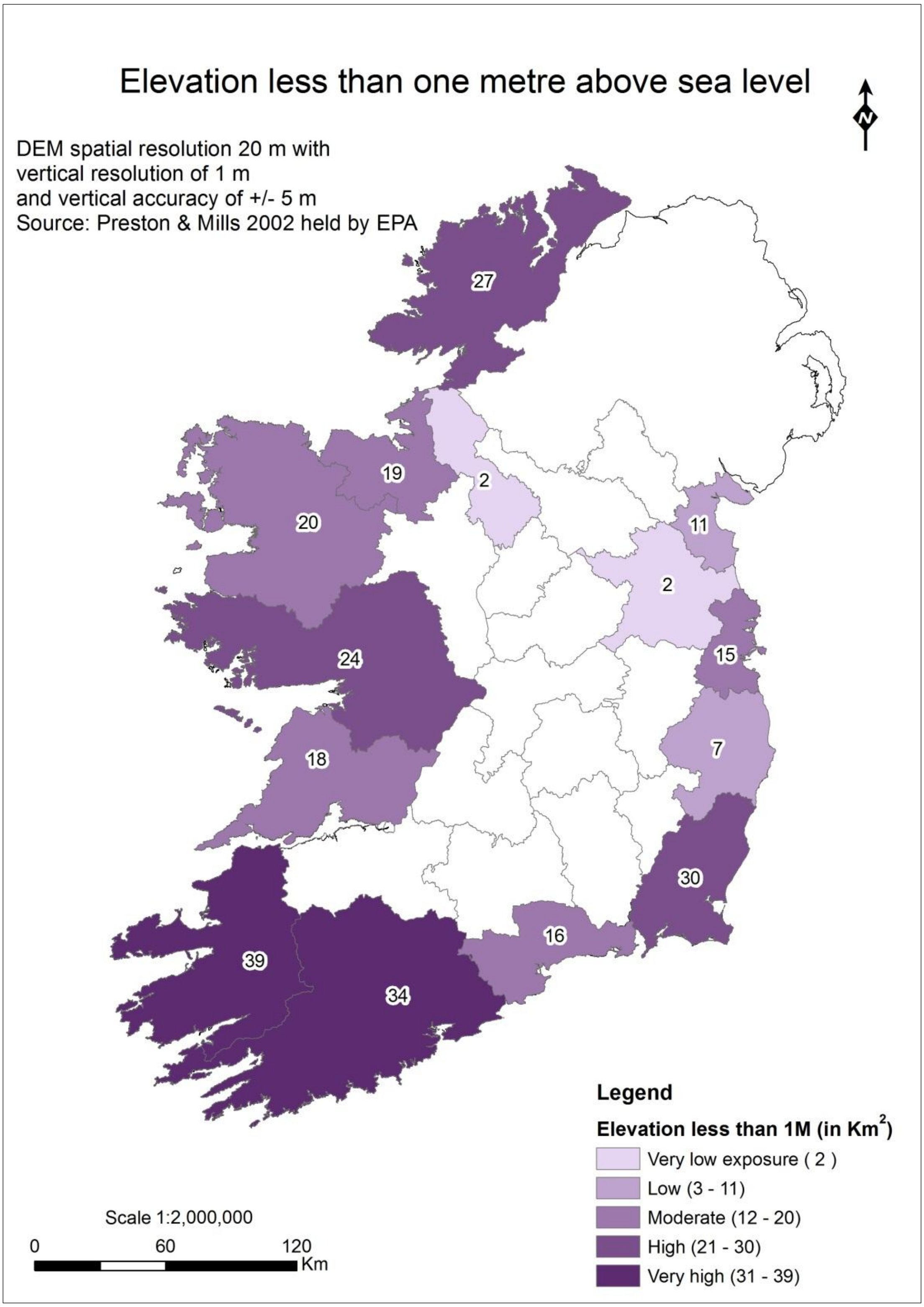
Map C.9 Protected species relative ranking



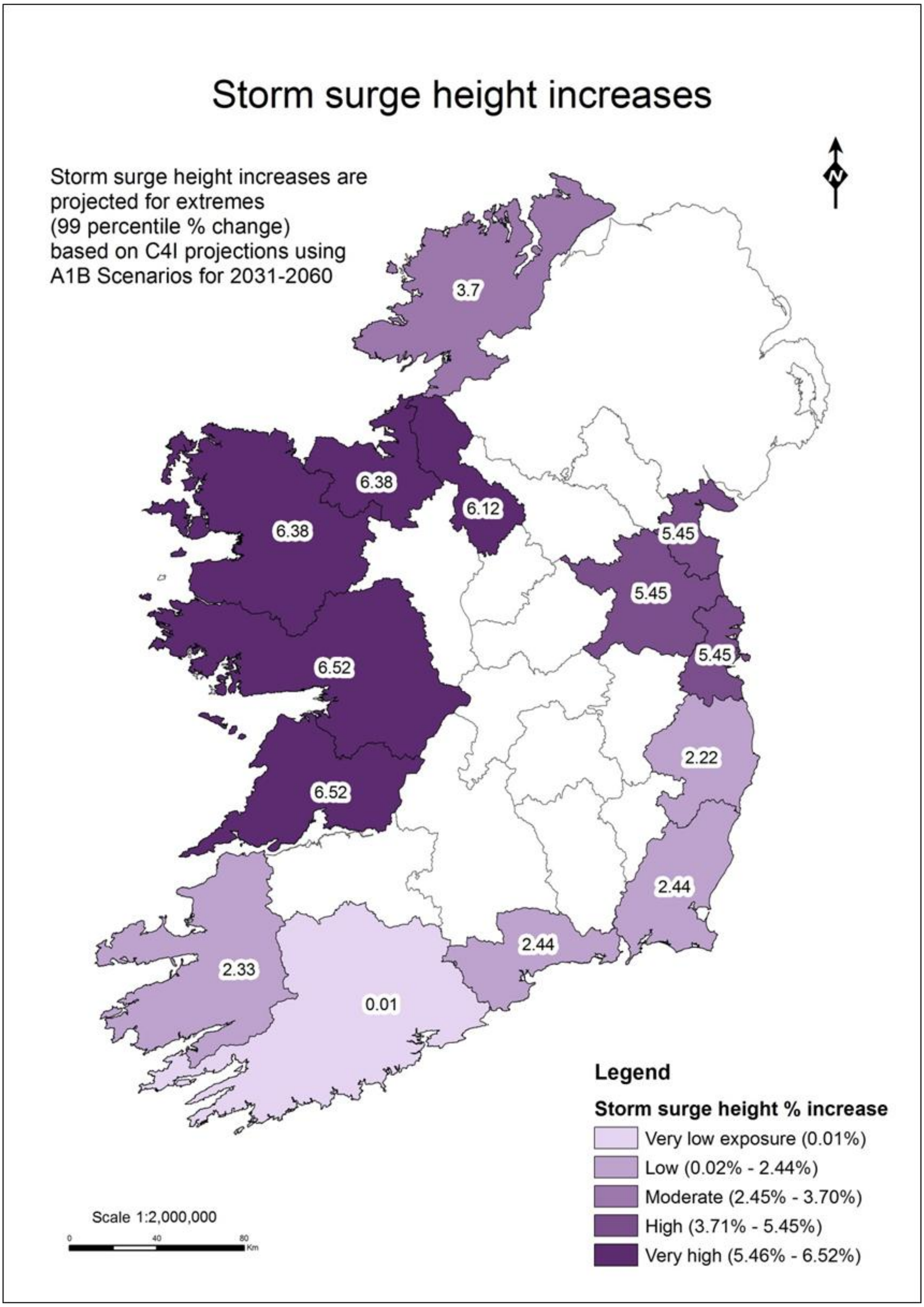
Map C.10 Coastline at risk relative ranking



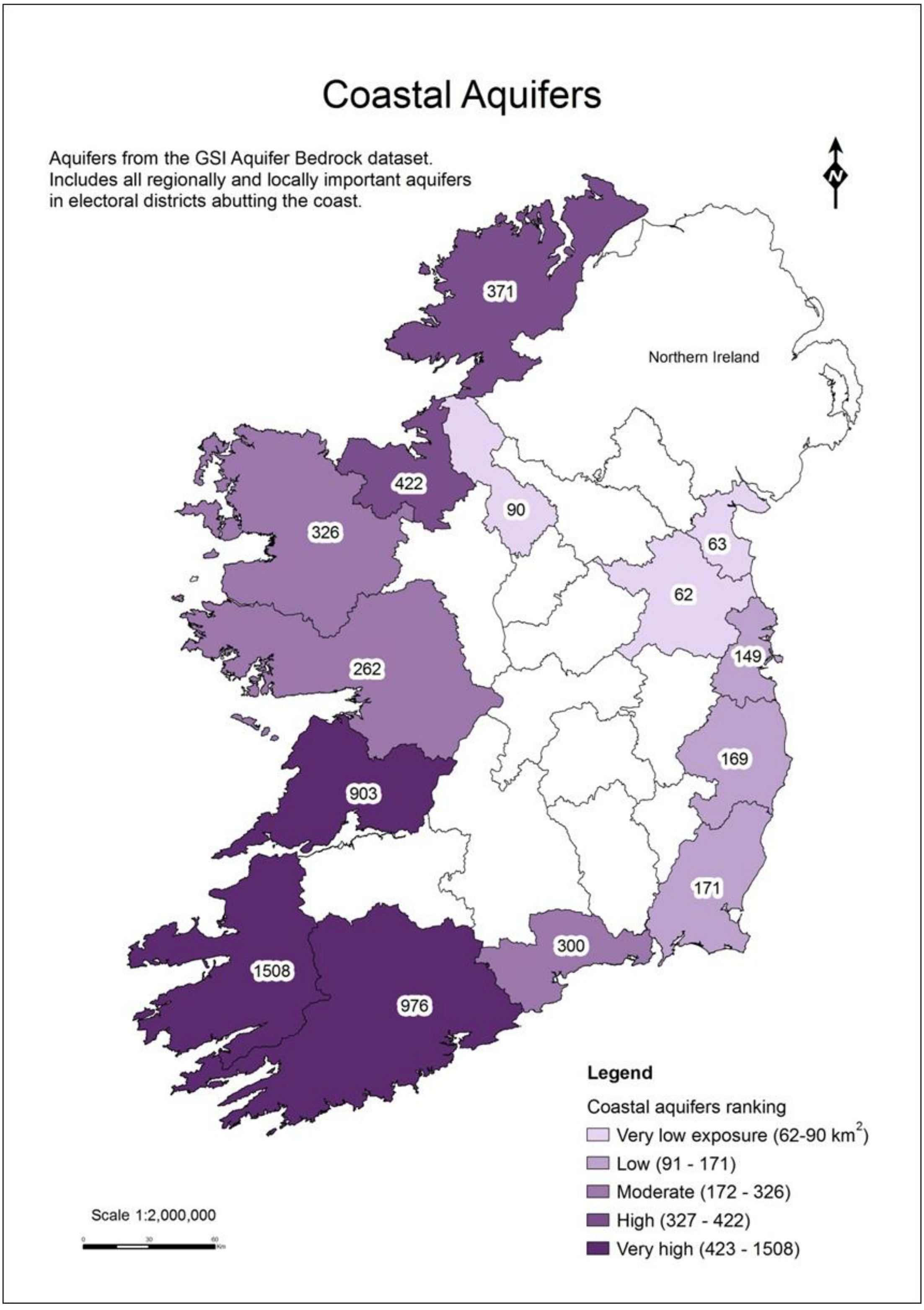
Map C.11 Erosion trends relative ranking



Map C.12 Elevation less than one metre above sea level relative ranking



Map C.13 Storm surge height increases relative ranking



Map C.14 Coastal aquifers relative ranking

Appendix D. Summary Tables

Table D.1 Sectors addressed by added measures in development plans

Local Authorities	Sectors Addressed by Added Measures in Plans										
NAME	Climate	Energy Demand	Energy Renewables	Flooding	Transportation	Coastal	Biodiversity	Water Resources	Green Infrastructure	Carbon Sequestration	Total Added measures
Carlow	1	1	1	1	1			1		1	7
Cavan	1	1	1	1	1		1	1	1	1	9
Clare	1	1	1	1	1	1		1	1	1	9
Cork City		1	1	1	1	1		1	1	1	8
Cork County	1	1	1	1	1	1					6
Donegal	1	1	1	1	1	1				1	7
Dublin City	1	1	1	1	1	1		1	1		8
Dún Laoghaire-Rathdown	1	1	1	1	1	1				1	7
Fingal	1	1	1	1	1	1	1	1	1		9
Galway City	1	1	1	1	1	1		1	1		8
Galway County	1		1		1	1					4
Kerry	1	1	1	1	1	1		1			7
Kildare	1	1	1	1	1			1	1		7
Kilkenny	1	1	1	1	1			1	1	1	8
Laois	1	1	1	1	1			1	1	1	8
Leitrim		1	1		1	1				1	5
Limerick City	1	1	1	1	1	1	1	1	1		9
Limerick County	1	1	1		1	1					5
Longford	1	1	1	1	1			1			6
Louth		1	1	1	1	1		1		1	7
Mayo	1	1	1	1	1	1			1	1	8
Meath	1	1	1	1	1	1	1		1	1	9
Monaghan	1	1	1	1	1				1	1	7
Offaly	1		1	1	1			1			5
Roscommon		1	1		1						3
Sligo	1	1	1	1	1	1		1			7
South Dublin	1	1	1	1	1		1		1	1	8
Tipperary North	1	1	1	1	1			1		1	7
Tipperary South	1	1	1	1	1			1			6
Waterford City	1	1	1	1	1						5
Waterford County	1	1	1	1	1	1				1	7
Westmeath	1	1	1	1	1			1	1	1	8
Wexford	1	1	1	1	1	1		1	1	1	9
Wicklow	1	1	1	1	1	1	1	1	1	1	10
Total by Sector	30	32	34	30	34	20	6	21	17	19	243

Table D.2 Relative Ranking Category values

Sector	Indicator	Very low	Low	Moderate	High	Very high
Flooding	Floods	52-89	90-154	155-208	209-267	268-515
	W. Precip.	10.2-11.6%	11.7-14.5%	14.6-16.0%	16.1-17.9%	18.0-19.5%
	Exposure	1.5	1.6 – 2.0	2.1 – 3.0	3.1 – 4.0	4.1 – 4.5
	Impact	0.0 – 0.4	0.5 – 2.7	2.8 – 7.4	7.5 – 12.0	12.1 – 20.1
Landslides	Slide events	0 - 8	9 - 22	23 – 41	42 – 124	125 - 428
	Peat	0.0-3.1%	3.2-6.6%	6.7-15.8%	15.9-28.1%	28.2-38.6%
	Slope	0.0 - 0.7%	0.8-2.4%	2.5-5.7%	5.8-8.6%	8.7-16.9%
	Exposure	1.0 – 1.3	1.4 – 2.0	2.1 – 2.7	2.8 – 3.7	3.8 – 4.3
	Impact	0.0 – 0.3	0.4 – 1.2	1.3 – 3.3	3.4 – 4.6	4.7 – 8.9
Water Supply	RAL	0 – 4%	5 – 12%	13 – 20%	21 – 36%	37 – 49%
	S. Precip.	-6.7 to -5.1%	-8.0 to -6.8%	-9.1 to -8.1%	-10.1 to -9.2%	-11.3 to -10.2%
	Exposure	1.0	1.1 – 2.0	2.1 – 2.5	2.6 – 3.5	3.6 – 4.5
	Impact	0.03 – 0.13	0.14 – 0.24	0.25 – 2.83	2.84 – 4.74	4.75 – 9.03
Biodiversity	Sites	36 - 59%	20 – 35%	15 – 19%	7 – 14%	3 – 6%
	Species	26 – 37	24 – 25	18 – 23	11 – 17	6 - 10
	Exposure	1.0	1.1 – 2.0	2.1 – 3.0	3.1 – 4.0	4.1 – 5.0
	Impact	0.03 – 0.50	0.51 – 2.40	2.41 – 4.74	4.75 – 9.56	9.57 – 17.86
Coastal Erosion	Coast Risk	5 - 12	13 - 22	23 - 59	60 - 170	171 - 652
	E Trends	0 - 19	20 - 37	38 - 71	72 - 122	123 - 180
	Exposure	1.0	1.1 - 1.5	1.6 - 2.5	2.6 - 3.5	3.6 - 4.5
	Impact	0 - 5	6 - 20	21 – 93	94 – 792	793 - 1733
Sea Level Rise	Elevation	2-7	8-16	17-20	21-30	31-39
	Surge	0.01	0.02 – 2.44	2.45 – 3.70	3.71 – 5.45	5.46 – 6.52
	C. Aquifers	62-90	91-171	172-326	327-422	423-1508
	Exposure	1.7 - 2.0	2.1 - 2.3	2.4 - 2.7	2.8 - 3.7	3.8 - 4.3
	Impact	0 – 2	3 – 8	9 – 17	18 – 168	169 - 1733
Overall Climate Exposure		0.54 – 0.60	0.61 – 0.69	0.70 – 0.76	0.77 – 0.84	0.85 – 0.99
Overall Climate Impact		0.01 – 0.05	0.06 – 0.09	0.10 – 0.92	0.93 – 1.86	1.87 – 3.48
Capacity	C. D. Plan	9 – 10	8	7	5 – 6	3 - 4
	C Strategy	Published	Adopted	In process	Objective	No plans
	FP Staff	16.3 - 36.5	11.3 - 16.2	7.0 - 11.2	3.1 – 6.9	1.0 – 3.0
	Exposure	1.3	1.4 – 2.3	2.4 – 3.0	3.1 – 3.7	3.8 – 4.7
	Impact	0.04 - 0.20	0.21 – 0.78	0.79 – 1.54	1.55 – 4.45	4.46 – 6.28

Table D.3 Exposure value for each sector by local authority

	Flooding	Landslides	Water Supply	Biodiversity	Coastal Erosion	Sea Level Rise	Combined		Adaptive Capacity
Carlow (CW)	3.0	2.0	2.5	4.0	n/a	n/a	0.75		3.3
Cavan (CN)	3.0	2.0	3.0	4.5	n/a	n/a	0.83		3.7
Clare (CE)	2.0	1.7	1.0	1.5	3.0	4.3	0.58		1.3
Cork									
Cork City (C*)	4.0	2.3	3.0	2.5	4.0	3.7	0.83		2.0
Co. Cork (C+)									2.7
Donegal (DL)	2.5	3.3	3.5	2.0	3.5	3.7	0.76		3.3
Great Dublin Area									
Dublin City (D)	4.5	2.0	4.0	4.0	1.5	2.7	0.78		1.3
Dún Laoghaire-Rathdown (DLR)									2.0
Fingal (F)									1.3
Galway									
Galway City (G*)	4.0	2.7	3.0	1.0	4.0	4.0	0.79		3.0
Co. Galway (G+)									3.7
Kerry (KY)	2.0	4.0	4.5	1.0	4.5	4.0	0.81		3.3
Kildare (KE)	3.5	1.3	1.5	4.0	n/a	n/a	0.69		3.3
Kilkenny (KK)	3.5	1.0	2.5	3.5	n/a	n/a	0.73		3.0
Laois (LS)	2.5	1.3	2.5	4.5	n/a	n/a	0.73		2.3
Leitrim (LM)	1.5	3.7	3.0	4.0	1.0	2.3	0.60		4.7
Limerick									
Limerick City (L)	2.5	1.7	2.5	3.5	n/a	n/a	0.68		2.3
Co. Limerick (LK)									2.7
Longford (LD)	2.0	1.7	2.5	4.5	n/a	n/a	0.71		3.3
Louth (LH)	2.5	1.3	1.5	3.0	2.0	2.3	0.54		3.3
Mayo (MO)	3.0	3.7	3.5	1.5	4.5	3.7	0.82		3.7
Meath (MH)	3.5	1.0	2.5	4.0	1.0	2.0	0.60		1.3
Monaghan (MN)	2.5	1.0	4.0	5.0	n/a	n/a	0.89		4.0
Offaly (OY)	2.5	2.3	2.0	4.0	n/a	n/a	0.68		3.0
Roscommon (RN)	3.0	1.7	4.5	4.0	n/a	n/a	0.91		3.3
Sligo (SO)	3.0	3.7	4.5	3.0	2.5	4.0	0.84		3.7
South Dublin (SD)	4.5	2.0	4.0	4.0	n/a	n/a	0.73		1.3
Tipperary North (TN)	2.0	1.7	2.5	3.0	n/a	n/a	0.60		2.7
Tipperary South (TS)	4.0	2.0	4.0	4.5	n/a	n/a	0.99		2.7
Waterford									
Waterford City (W)	4.0	2.0	2.5	3.0	1.5	2.3	0.64		3.3
Co. Waterford (WD)									3.0
Westmeath (WH)	2.5	1.7	2.0	4.0	n/a	n/a	0.67		3.3
Wexford (WX)	3.0	1.7	1.0	1.5	3.0	2.7	0.56		2.3
Wicklow (WW)	3.5	4.3	3.5	1.5	2.0	1.7	0.56		2.7
National Average	2.9	2.2	2.9	3.2	2.7	3.1	0.73		2.8

Table D.4 Impact values for each sector listed by local authority

	Population Density	Flooding	Landslides	Water Supply	Biodiversity	Coastal Erosion *	Sea Level Rise*	Combined		Adaptive Capacity
Carlow (CW)	0.06	0.18	0.12	0.15	0.25	n/a	n/a	0.05		0.20
Cavan (CN)	0.04	0.11	0.08	0.11	0.17	n/a	n/a	0.03		0.14
Clare (CE)	0.03	0.07	0.06	0.03	0.05	11.0	15.8	0.02		0.04
Cork City (C*)	3.01	12.04	6.92	9.03	7.53	0	0	2.50		6.02
Co. Cork (C+)	0.05	0.21	0.12	0.16	0.13	5.1	4.7	0.04		0.14
Donegal (DL)	0.03	0.08	0.11	0.11	0.07	3.2	3.4	0.02		0.11
Dublin City (D)	4.47	20.09	8.93	1.78	17.86	568.1	1022.5	3.48		5.80
Dún Laoghaire-Rathdown (DLR)	1.64	7.37	3.28	6.55	6.55	792.2	1425.9	1.28		3.28
Fingal (F)	0.60	2.70	1.20	2.40	2.40	93.3	167.9	0.47		0.78
Galway City (G*)	1.49	5.93	4.00	4.45	1.48	1733.1	1733.1	1.17		4.45
Co. Galway (G+)	0.03	0.11	0.08	0.09	0.03	1.0	1.0	0.02		0.11
Kerry (KY)	0.03	0.06	0.12	0.13	0.03	2.6	2.3	0.02		0.10
Kildare (KE)	0.12	0.43	0.16	0.19	0.50	n/a	n/a	0.09		0.41
Kilkenny (KK)	0.05	0.16	0.05	0.11	0.16	n/a	n/a	0.03		0.14
Laois (LS)	0.05	0.12	0.06	0.12	0.21	n/a	n/a	0.03		0.11
Leitrim (LM)	0.02	0.03	0.07	0.06	0.08	0.0	0.0	0.01		0.09
Limerick City (L)	2.72	6.83	4.64	6.83	9.56	n/a	n/a	1.86		6.28
Co. Limerick (LK)	0.05	0.12	0.08	0.12	0.17	n/a	n/a	0.03		0.13
Longford (LD)	0.04	0.07	0.06	0.09	0.16	n/a	n/a	0.03		0.14
Louth (LH)	0.15	0.37	0.19	0.22	0.45	12.4	14.3	0.08		0.55
Mayo (MO)	0.02	0.07	0.09	0.08	0.03	1.1	0.9	0.02		0.09
Meath (MH)	0.08	0.27	0.08	0.20	0.31	0	0.5	0.05		0.10
Monaghan (MN)	0.05	0.12	0.05	0.19	0.23	n/a	n/a	0.04		0.19
Offaly (OY)	0.04	0.10	0.09	0.08	0.15	n/a	n/a	0.03		0.12
Roscommon (RN)	0.03	0.08	0.04	0.11	0.10	n/a	n/a	0.02		0.08
Sligo (SO)	0.04	0.11	0.13	0.16	0.11	4.9	7.8	0.03		0.13
South Dublin (SD)	1.19	5.33	2.37	4.74	4.74	n/a	n/a	0.92		1.54
Tipperary North (TN)	0.03	0.07	0.06	0.09	0.10	n/a	n/a	0.02		0.10
Tipperary South (TS)	0.04	0.16	0.08	0.16	0.18	n/a	n/a	0.04		0.11
Waterford City (W)	1.12	4.52	2.26	2.83	3.39	n/a	n/a	0.72		3.73
Co. Waterford (WD)	0.04	0.15	0.07	0.09	0.11	3.4	5.2	0.02		0.11
Westmeath (WH)	0.05	0.12	0.08	0.09	0.09	n/a	n/a	0.03		0.15
Wexford (WX)	0.06	0.12	0.11	0.06	0.09	16.0	14.4	0.04		0.17
Wicklow (WW)	0.07	0.24	0.29	0.24	0.10	19.7	16.7	0.05		0.18
National Average	0.52	2.02	1.06	1.70	1.70	163.4	221.8	0.39		1.05

Table D.5 Summary table of greatest exposures and impacts

	Greatest exposure		Greatest impact
	Very high	High	(Very high and High)
Flooding	Dublin	Cork Galway Kildare Kilkenny Meath South Tipperary Waterford Wicklow	Dublin City Cork City
Landslides	Leitrim Sligo Mayo Kerry Wicklow	Donegal Galway	Cork City Dublin City Galway City Limerick City
Water supply	Dublin Kerry Monaghan Roscommon Sligo	Cavan Cork Donegal Galway Leitrim Mayo Wicklow	Dublin City Cork City Dún Laoghaire-Rathdown Limerick City
Biodiversity	Cavan Laois Longford Monaghan South Tipperary	Carlow Dublin Kildare Leitrim Limerick Meath Offaly	Cork City Dublin City Dún Laoghaire-Rathdown Limerick City
Coastal erosion	Cork Galway Kerry Mayo	Clare Donegal Wexford	Galway City Dublin City Dún Laoghaire-Rathdown
Sea level rise	Clare Kerry Galway Sligo	Cork Donegal Mayo	Dublin City Dún Laoghaire-Rathdown Fingal Galway City Wicklow
Combined physical	Monaghan South Tipperary	Carlow Cork Dublin Galway Kerry Mayo Roscommon Sligo	Cork City Dublin City Dún Laoghaire-Rathdown Galway City Limerick City

Table D.6 Categories of exposure and impact for each sector by council

	Flooding	Landslides	Water Supply	Biodiversity	Coastal Erosion	Sea Level Rise	Combined Physical	Adaptive Capacity
Carlow (CW)	3 (1)	2 (1)	3 (2)	4 (1)	n/a	n/a	4 (1)	3 (1)
Cavan (CN)	3 (1)	2 (1)	4 (1)	5 (1)	n/a	n/a	3 (1)	4 (1)
Clare (CE)	2 (1)	2 (1)	1 (1)	2 (1)	4 (2)	5 (3)	1 (1)	1 (1)
Cork City (C*)	4 (4)	3 (5)	4 (4)	3 (4)	5 (1)	4 (1)	4 (5)	2 (5)
Co. Cork (C+)	4 (1)	3 (1)	4 (2)	3 (1)	5 (1)	4 (2)	4 (1)	3 (1)
Donegal (DL)	3 (1)	4 (1)	4 (1)	2 (1)	4 (1)	4 (2)	3 (1)	4 (1)
Dublin City (D)	5 (5)	2 (5)	5 (5)	4 (5)	2 (4)	3 (5)	4 (5)	1 (5)
Dún Laoghaire-Rathdown(DLR)	5 (3)	2 (3)	5 (4)	4 (4)	2 (4)	3 (5)	4 (4)	2 (4)
Fingal (F)	5 (2)	2 (2)	5 (3)	4 (2)	2 (3)	3 (4)	4 (3)	1 (2)
Galway City (G*)	4 (3)	3 (4)	4 (3)	1 (2)	5 (5)	5 (5)	4 (4)	3 (4)
Co. Galway (G+)	4 (1)	3 (1)	4 (1)	1 (1)	5 (1)	5 (1)	4 (1)	4 (1)
Kerry (KY)	2 (1)	5 (1)	5 (1)	1 (1)	5 (1)	5 (1)	4 (1)	4 (1)
Kildare (KE)	4 (1)	1 (1)	2 (2)	4 (1)	n/a	n/a	2 (2)	4 (2)
Kilkenny (KK)	4 (1)	1 (1)	3 (1)	4 (1)	n/a	n/a	3 (1)	3 (1)
Laois (LS)	3 (1)	1 (1)	3 (1)	5 (1)	n/a	n/a	3 (1)	2 (1)
Leitrim (LM)	1 (1)	4 (1)	4 (1)	4 (1)	1 (1)	2 (1)	1 (1)	5 (1)
Limerick City (L)	3 (3)	2 (4)	3 (4)	4 (4)	n/a	n/a	2 (4)	2 (5)
Co. Limerick (LK)	3 (1)	2 (1)	3 (1)	4 (1)	n/a	n/a	2 (1)	3 (1)
Longford (LD)	2 (1)	2 (1)	3 (1)	5 (1)	n/a	n/a	3 (1)	4 (1)
Louth (LH)	3 (1)	1 (1)	2 (2)	3 (1)	3 (2)	2 (3)	1 (2)	4 (2)
Mayo (MO)	3 (1)	4 (1)	4 (1)	2 (1)	5 (1)	4 (1)	4 (1)	4 (1)
Meath (MH)	4 (1)	1 (1)	3 (2)	4 (1)	1 (1)	1 (1)	1 (1)	1 (1)
Monaghan (MN)	3 (1)	1 (1)	5 (2)	5 (1)	n/a	n/a	5 (1)	5 (1)
Offaly (OY)	3 (1)	3 (1)	2 (1)	4 (1)	n/a	n/a	2 (1)	3 (1)
Roscommon (RN)	3 (1)	2 (1)	5 (1)	4 (1)	n/a	n/a	4 (1)	4 (1)
Sligo (SO)	3 (1)	4 (1)	5 (2)	3 (1)	3 (1)	5 (2)	4 (1)	4 (1)
South Dublin (SD)	5 (3)	2 (3)	5 (3)	4 (3)	2 (1)	3 (1)	4 (3)	1 (3)
Tipperary North (TN)	2 (1)	2 (1)	3 (1)	3 (1)	n/a	n/a	1 (1)	3 (1)
Tipperary South (TS)	4 (1)	2 (1)	5 (2)	5 (1)	n/a	n/a	5 (1)	3 (1)
Waterford City (W)	4 (3)	2 (3)	3 (3)	3 (3)	2 (1)	2 (1)	2 (3)	4 (4)
Co. Waterford (WD)	4 (1)	2 (1)	3 (1)	3 (1)	2 (1)	2 (2)	2 (1)	3 (1)
Westmeath (WH)	3 (1)	2 (1)	2 (1)	4 (1)	n/a	n/a	2 (1)	4 (1)
Wexford (WX)	3 (1)	2 (1)	1 (1)	2 (1)	4 (2)	3 (3)	1 (1)	2 (1)
Wicklow (WW)	4 (1)	5 (1)	4 (2)	2 (1)	3 (2)	1 (3)	1 (1)	3 (1)
National Average	3 (2)	3 (2)	3 (2)	3 (2)	3 (2)	3 (3)	3 (2)	3 (2)

Appendix E. Surveys

2009 Local Authority Survey

Climate Change Impacts

1. Please indicate how much you expect each area to impact your county due to projected climate change (time frame 2000 – 2050).

	High Impact	Limited Impact	No anticipated impact
Increased flooding			
Water supply (quality/quantity)			
Biodiversity			
Coastal (erosion/sea level rise)			
Landslides			
Agriculture			
Higher temperatures			
Other:			
Other:			

2. In your experience, what level of government implements the most actions for each sector? (*Please tick all that apply*)

impact	City/County	Regional	Central Government
increased flooding			
Water Supply (quality/quantity)			
Biodiversity			
Coastal (erosion/sea level rise)			
Landslides			
Agriculture			
Higher temperatures			
Other:			
Other:			

3. Please describe how climate change impacts are addressed (directly and indirectly) within your City/County Development Plan.

Climate change impact:____

How addressed:____

Climate change impact:____

How addressed: ____

Climate change impact:____

How addressed: ____

City/County Development Plans

4. Please list the EU and national regulations which would have possible synergies with climate change adaptation measures as far as the City/County Development Plan is concerned.

____

____

____

____

5. City/County Development Plans address the general well-being of the area. Please rank the different priorities based on the experience in your city/county.

	Highest priority	High priority	Medium priority	Lesser priority	Not addressed
Economic development					
Residential Density					
Environmental protection					
Biodiversity					
Cultural heritage					
Other					

6. City/County Development Plans are renewed each six years. Please list strategic issues that extend beyond the time and how these concerns are addressed within your Development Plan.

Strategic Issue:_______________________________________

How addressed: _______________________________________

____

Strategic Issue:_______________________________________

How addressed: _______________________________________

____

Strategic Issue:_______________________________________

How addressed: _______________________________________

____

Strategic Issue:_______________________________________

How addressed: _______________________________________

____

Current and potential measures

7. Please describe exceptions/variations to the development plan which negatively impact the council's capacity to deal with climate change impacts.

    ____

    ____

    ____

    ____

8. Please describe any <u>risk assessments</u> undertaken by the Planning Department which relate to the impacts of climate change.

    ____

    ____

    ____

    ____

9. Each local authority will likely adapt to climate change impacts differently. Please describe any examples of best climate adaptation practice that you would like to highlight.

    Example 1: ____

    ____

    Example 2: ____

    ____

    Example 3:____

    ____

10. What governmental bodies *relating to planning* does your city/county council participate in? *please tick all that apply*

    _____ Local government associations
    _____ Environmental governance associations
    _____ Regional assemblies
    _____ International associations for local government officials

Challenges

11. From the list of issues below, what difficulties does your council face now or in the future with regards to climate change planning? *Please tick all that apply*

	Currently	Anticipated in future
Funding and resources		
a) Lack of funding	_____	_____
b) Insufficient staff/staff time. . . .	_____	_____
c) Lack of specialist knowledge in the council .	_____	_____
d) No nominated champion to drive it forward. .	_____	_____
Barriers		
e) Insufficient local authority powers . .	_____	_____
f) Risk of litigation (planning appeals etc.) ..	_____	_____
g) Lack of awareness or interest from the public .	_____	_____
h) Lack of awareness or interest from councillors.	_____	_____
i) Lack of awareness or interest from staff .	_____	_____
j) Others issues take higher priority in the authority	_____	_____
k) Lack of awareness or interest from other public sector organisations	_____	_____
l) Lack of appropriate central government guidance	_____	_____
m) Lack of appropriate central government regulations	_____	_____
n) Perceived lack of priority or leadership from central government . .	_____	_____
Co-ordination		
o) Difficulty co-ordinating different departments within authority	_____	_____
s) Difficulty co-ordinating regionally between adjacent areas	_____	_____
t) Difficulty co-ordinating between county and town councils	_____	_____
u) Difficulty co-ordinating between county and regional councils	_____	_____
v) Difficulty embedding climate change actions in other plans and strategies (e.g. reducing pollution, traffic congestion etc.)	_____	_____
w) Other (please specify)	_____	_____

____

Information needs

12. How important is it for planners to be fully informed regarding climate change **science** (for example climate models)? *please tick only one box*

Very Important	Somewhat Important	Not sure	Somewhat unnecessary	Very unimportant

13. How important is it for planners to be fully informed regarding climate change **impacts**? *Please tick only one box*

Very Important	Somewhat Important	Not sure	Somewhat unnecessary	Very unimportant

14. Please rate information sources as far as usefulness in preparing for climate change. *Please rate each source in only one box*

Source	Very useful	Useful	Not useful	Don't know
Newspapers				
Internet				
Guidelines from central government				
EU Directives				
Journal articles				
Examples from other countries				
Other:				

15. What type of information would be useful to help prepare for climate impacts? *Please rate each type in only one box*

Type of Information	Very useful	Useful	Not useful	Don't know
Best practice examples				
Checklist to address climate change				
Educational material/programmes				
Model policy				
Scientific facts				
List of useful websites				
Other (please specify)				

Contact details of person completing questionnaire. Your responses are confidential. No names or individual information will be used or released to the public or government bodies without specific prior written consent. Thank you very much for completing this survey and giving your input.

Name of your authority:____________________________

Your name: ____________________________

Position: ____________________________

Telephone: ____________________________

E-mail: ____________________________

2011 Local Authority Survey

1) Please indicate how much you expect each area to impact your county due to projected climate change (time frame 2000 – 2050).

	High Impact	Limited Impact	No anticipated impact
Increased flooding			
Water supply (quality/quantity)			
Biodiversity			
Coastal (erosion/sea level rise)			
Landslides			
Other:			

2) In your opinion, to what extent have the impacts of projected climate change been considered in relation to your council's operation and service delivery? *Please tick one box only*

To a considerable extent □
To some extent □
To a small extent □
Not considered at all □

3) In your opinion, to what extent have the impacts of projected climate change been considered in your council's policy, plans and programmes? *Please tick one box only*

To a considerable extent □
To some extent □
To a small extent □
Not considered at all □

4) Does your authority have a climate change strategy or policy?

Please tick one box only

Yes, completed and published	
Yes, completed but not published	
Yes, in development	
No, but intend to produce one	
No, and no current plans to produce one	

5) Please list your council's 3 top priorities in terms of mitigation (reducing emissions of greenhouse gases) *Please tick only three*

Increase levels of renewable energy □
Increase energy efficiency □
Develop planning policies to cut carbon emissions □
Greener procurement □
Awareness raising and education in the community □
Waste reduction □
Employee travel □
Increasing the uptake of public transport □

6) Please list your council's 3 top priorities in terms of adaptation (responding to the impacts of projected climate change) *Please tick only three*

Climate impacts on

Service delivery □
Local community □
Local economy □
Natural environment and biodiversity □

Public health ☐
Built environment ☐
Managing flood risks ☐
Managing water risks ☐
Updating planning policies to address climate change ☐

7) From the list of issues below, what difficulties does your council face now or in the future with regards to climate change planning? *Please tick all that apply*

	Currently	Anticipated in future
Funding and resources		
a) Lack of funding		
b) Insufficient staff/staff time		
c) Lack of specialist knowledge in the council		
d) No nominated champion to drive it forward		
Barriers		
e) Insufficient local authority powers		
f) Risk of litigation (e.g. planning appeals)		
g) Other issues take higher priority in the authority		
h) Difficulty embedding climate change actions in other plans and strategies (e.g. reducing pollution, traffic plans)		
Lack of awareness or interest from		
i) the public		
j) councillors		
k) the staff		
l) other public sector organisations		
Lack of appropriate central government		
m) guidance		
n) regulations		
o) priority or leadership		
Co-ordination difficulties		
p) between departments within the authority		
q) between adjacent areas		
r) between county and town councils		
s) between county and regional authorities		
Other		

Contact details of person completing questionnaire. Your responses are confidential. No names or individual information will be used or released to the public or government bodies without specific prior written consent. Thank you very much for completing this survey and giving your input.

Name of your authority: ______________________

Your name: ______________________

Position: ______________________

Telephone: ______________________

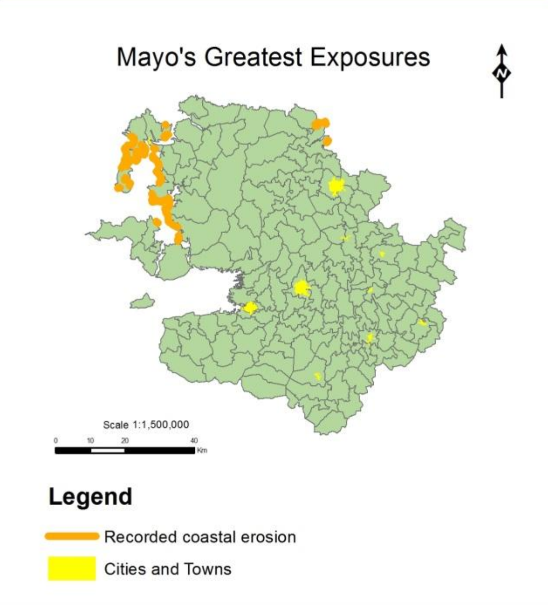
E-mail: ______________________

Appendix F. Case Study summary sheets

Mayo

Greatest Exposure:

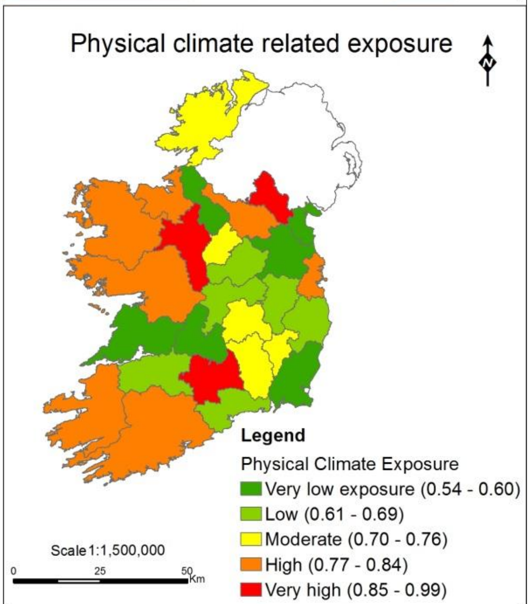
- Sea level rise
- Coastal erosion



Sector Exposures:	Mayo	Ireland
Floods * Flood events * Precipitation 2031-2060	3.0	2.9
Landslides * Recorded events * > 15° slope (% area) * Peatlands (% area)	3.7	2.2
Water Supply * Public water supply at risk * Precipitation 2031-2060	3.5	2.9
Coastal Erosion * Coast at risk * Erosion trends	4.5	2.7
Sea Level Rise * Elevation less than 1 metre * Storm surge * Aquifers	3.7	3.1
Biodiversity * Protected sites (% area) * Protected species	1.5	3.2
Adaptive Capacity * Added measures in plan * Climate change strategy * Forward planning staff	3.7	2.8

	Classes				
Exposures	Very low	Low	Moderate	High	Very High
Floods	1.5 - 2.0	2.1 - 2.5	2.6 - 3.0	3.1 - 3.5	3.6 - 4.5
Landslides	1.0 - 1.3	1.4 - 2.0	2.1 - 2.7	2.8 - 3.7	3.8 - 4.3
Water supply	1.0	1.1 - 2.0	2.1 - 2.5	2.6 - 3.5	3.6 - 4.5
Coastal erosion	1.0	1.1 - 1.5	1.6 - 2.5	2.6 - 3.5	3.6 - 4.5
Sea level rise	1.7 - 2.0	2.1 - 2.3	2.4 - 2.7	2.8 - 3.7	3.8 - 4.3
Biodiversity	1.0	1.1 - 2.0	2.1 - 3.0	3.1 - 4.0	4.1 - 5.0
Adaptive capacity	1.3	1.4 - 2.3	2.4 - 3.0	3.1 - 3.7	3.8 - 4.7

*For example, floods sub-index value is the average of (Flood events and Projected precipitation)



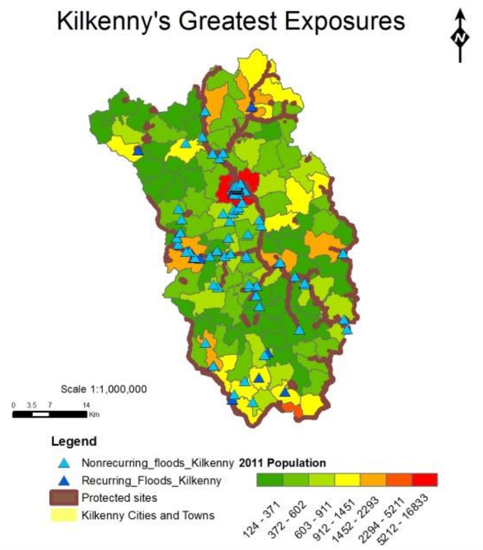
Sectoral weighting based on 2009 survey of local authorities

	Floods	Water	Biodiversity	Coast	Landslides
Coastal counties	24.3%	18.6%	20.7%	23.6%	12.9%
Inland counties	30.3%	33.3%	27.3%	n/a	9.1%

Figure F.1 Mayo County Council Summary Sheet

Kilkenny

Greatest Exposures:
- **Floods**
- **Biodiversity**



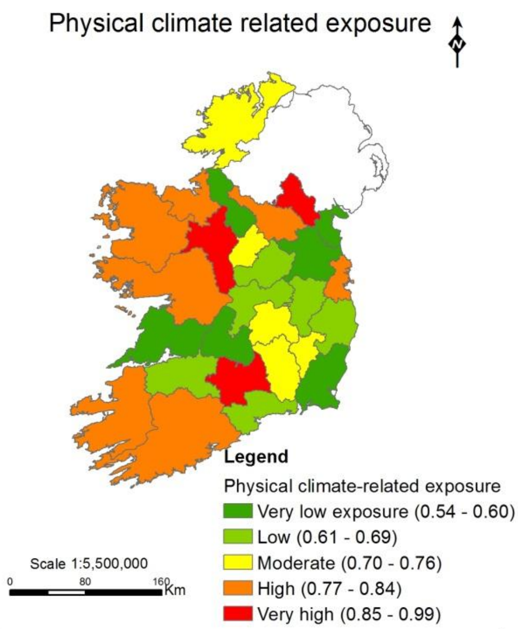
Kilkenny's Exposure Rankings for Indicators

	Very low	Low	Moderate	High	Very high
Flood Exposure					
*Recorded events					
* Precipitation 2031-2060					
Landslide Exposure					
*Recorded events					
*Peatlands					
*High slope					
Water Supply Exposure					
*Public water supply at risk					
*Precipitation 2031-2060					
Coastal Erosion Exposure					
*Coast at risk	n/a				
*Erosion trends	n/a				
Sea Level Rise Exposure					
*Elevation less than 1 metre	n/a				
*Storm surge	n/a				
*Aquifers	n/a				
Biodiversity Exposure					
*Protected sites					
*Protected species					
Adaptive Capacity Exposure					
*Added measures in plan					
*Climate change strategy					
*Forward planning staff					

Sector Exposures:	Kilkenny	Ireland
Floods * Flood events * Precipitation 2031-2060	3.5	2.9
Landslides * Recorded events * > 15° slope (% area) * Peatlands (% area)	1.0	2.2
Water Supply * Public water supply at risk * Precipitation 2031-2060	2.5	2.9
Coastal Erosion * Coast at risk * Erosion trends	n/a	2.7
Sea Level Rise * Elevation less than 1 metre * Storm surge * Aquifers	n/a	3.1
Biodiversity * Protected sites (% area) * Protected species	3.5	3.2
Adaptive Capacity * Added measures in plan * Climate change strategy * Forward planning staff	3.0	2.8

	Classes				
Exposures	Very low	Low	Moderate	High	Very High
Floods	1.5 - 2.0	2.1 - 2.5	2.6 - 3.0	3.1 - 3.5	3.6 - 4.5
Landslides	1.0 - 1.3	1.4 - 2.0	2.1 - 2.7	2.8 - 3.7	3.8 - 4.3
Water supply	1.0	1.1 - 2.0	2.1 - 2.5	2.6 - 3.5	3.6 - 4.5
Coastal erosion	1.0	1.1 - 1.5	1.6 - 2.5	2.6 - 3.5	3.6 - 4.5
Sea level rise	1.7 - 2.0	2.1 - 2.3	2.4 - 2.7	2.8 - 3.7	3.8 - 4.3
Biodiversity	1.0	1.1 - 2.0	2.1 - 3.0	3.1 - 4.0	4.1 - 5.0
Adaptive capacity	1.3	1.4 - 2.3	2.4 - 3.0	3.1 - 3.7	3.8 - 4.7

*For example, floods sub-index value is the average of (Flood events and Projected precipitation)

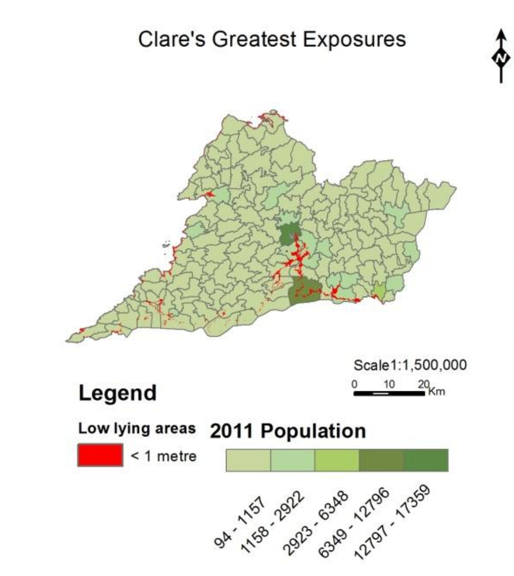


Sectoral weighting based on 2009 survey of local authorities					
	Floods	Water	Biodiversity	Coast	Landslides
Coastal counties	24.3%	18.6%	20.7%	23.6%	12.9%
Inland counties	30.3%	33.3%	27.3%	n/a	9.1%

Figure F.2 Kilkenny County Council Summary Sheet

Clare

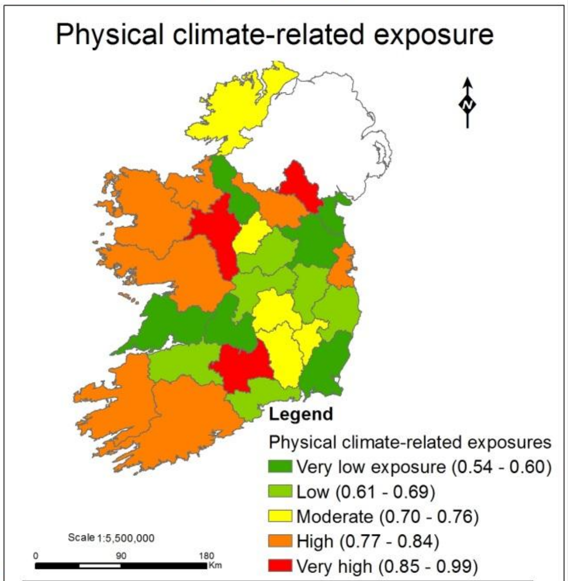
Greatest Exposures:
- **Sea Level Rise**
- **Coastal Erosion**



Sector Exposures:	Clare	Ireland
Floods * Flood events * Precipitation 2031-2060	2.0	2.9
Landslides * Recorded events * > 15° slope (% area) * Peatlands (% area)	1.7	2.2
Water Supply * Public water supply at risk * Precipitation 2031-2060	1.0	2.9
Coastal Erosion * Coast at risk * Erosion trends	3.0	2.7
Sea Level Rise * Elevation less than 1 metre * Storm surge * Aquifers	4.3	3.1
Biodiversity * Protected sites (% area) * Protected species	1.5	3.2
Adaptive Capacity * Added measures in plan * Climate change strategy * Forward planning staff	1.3	2.8

	Classes				
Exposures	Very low	Low	Moderate	High	Very High
Floods	1.5 - 2.0	2.1 - 2.5	2.6 - 3.0	3.1 - 3.5	3.6 - 4.5
Landslides	1.0 - 1.3	1.4 - 2.0	2.1 - 2.7	2.8 - 3.7	3.8 - 4.3
Water supply	1.0	1.1 - 2.0	2.1 - 2.5	2.6 - 3.5	3.6 - 4.5
Coastal erosion	1.0	1.1 - 1.5	1.6 - 2.5	2.6 - 3.5	3.6 - 4.5
Sea level rise	1.7 - 2.0	2.1 - 2.3	2.4 - 2.7	2.8 - 3.7	3.8 - 4.3
Biodiversity	1.0	1.1 - 2.0	2.1 - 3.0	3.1 - 4.0	4.1 - 5.0
Adaptive capacity	1.3	1.4 - 2.3	2.4 - 3.0	3.1 - 3.7	3.8 - 4.7

*For example, floods sub-index value is the average of (Flood events and Projected precipitation)



Sectoral weighting based on 2009 survey of local authorities

	Floods	Water	Biodiversity	Coast	Landslides
Coastal counties	24.3%	18.6%	20.7%	23.6%	12.9%
Inland counties	30.3%	33.3%	27.3%	n/a	9.1%

Figure F.3 Clare County Council Summary Sheet

Appendix G. Interview questions

Local authority case study interviews

Theme 1: Measures beyond policy documents:

- What measures are being taken that do not show up in the published policy documents?
- Are there best practice examples in your area for dealing with climate change?
- Would a copy of the council's draft climate change strategy be available for review?
- Are there key people dealing with climate change and how much do they influence actual measures?
- What information sources would you use to learn about climate change? Is this typical of other staff members?

Theme 2: Organisational challenges within the local authority departments:

- Is there a cross-departmental team within the local authority that deals with climate change?
- What other measures are in place to enhance shared knowledge among the different local authority departments?
- How would they describe their ideal government/governance structures?

Theme 3: How central government can support local adaptation:

- What forms of support would best enable local government to address climate change (e.g. designated funding, training, detailed risk assessments)?
- What suggestions would you offer to central government as far as providing legislative packing to deal with climate change?
- How much do requirements from central government drive local policies?

Theme 4: Synergies between other policy objectives and adaptation:

- When prioritising issues, are historical risks a determining factor or do political issues sometimes take precedence?
- Sustainable development, or quality of life, is often a stated objective. How is this realised in the local authority?
- Are there pre-existing environmental programmes within the local authority that enhance the response to climate change?

Regional Authority interview questions

- What is the Regional Authority's role in coordinating local authority actions?
- How do they perceive the EU's position on regionalisation?
- Are there good practice examples in your area for dealing with climate change?
- How are the Regional Authorities staffed and funded?
- Does the Regional Authority play a role in local accountability?
- Are there links between the different Regional Authorities?
- Are there links between the different sectors at the regional level?
- What suggestions would you offer to central government to improve climate measures?

Follow-up questions emailed to West Regional Authority:

- You noted that the regional authorities have quarterly meetings. Are there also linkages between the regional entities across the different sectors? (i.e. Waste Management, River Basin Management, and Regional Authorities)
- What recommendations could be made to balance the need to meet EU climate change goals with a need to respect the populace emphasis on rural settlement patterns?
- What recommendations could be made regarding increasing the autonomy of regional authorities in light of the current funding sources?
- What recommendations could be made regarding increasing a standardised approach in addressing climate change issues (i.e. SEA is one example)?

National government interview questions

Senior Planning Advisor

Theme 1: Regional Planning Guidelines

- Will there be a stronger role for Regional Authorities as the new guidelines are drawn-up?
- Is the goal of this to strengthen the regional level in Ireland?
- How will this play out?
- Is there a monitoring/enforcement role envisaged for regional authorities?

Theme 2: Subsidiarity

- If central and regional government will lay the ground rules for local governments, what role will city and county authorities play?
- How with the unique challenges facing different areas being kept as a key focus?
- What measures are being incorporated to address the local particularities of different areas?

Theme 3: National Spatial Strategy

- What synergies would you see between the National Climate Change Strategy and other central government documents?

Theme 4: Central government: adaptation vs. mitigation

- Adaptation in Ireland is still an outstanding issue – what contributions would you suggest that planning can contribute to this discussion?
- What is the status of the National Adaptation Strategy that is due out in 2009?
- Given the timeframe mismatch between current policies and delayed impacts – what role would you see for spatial planning in Ireland with regards to adaptation?

Principal Officer, Climate Change Policy Unit

- How are reductions addressed in the new Climate Change bill that is being prepared?
- What enforcement actions (by whom and what) are built into the new climate change legislation?
- If there is a new climate change entity under the EPA umbrella, what sort of funding will be provided to implement the policies?
- Regarding carbon reduction requirements, what criteria will be used and/or how will it be measured?

- How will climate change measures be funded?
- Are there any plans for mitigation reduction requirements at the local authority level? And, if so, what form would they take?
- With regards to adaptation, are there measures included in the Climate Change Bill? How will these measures be structured?
- What are central government's plans for addressing the dispersed population in Ireland?
- Given the limited success with other initiatives such as River Basin Management Plans, how will central government facilitate greater compliance with national objectives?

Principal Officer, Local Government Unit

- How would you describe the role for local authorities in dealing with sustainability and climate change?
- How do regional authorities fit into this picture?
- Central government funds local authorities and prescribes which activities they are required to undertake – what measures are in place to advance subnational adaptation measures?
- Also regarding funding issues, how is local government financing structured (how much latitude do local authorities have in allocation of resources)?
- The green paper on local government advocates an increase in local authority autonomy via self-reliant funding as well as other measures? How has this green paper been advanced and is the white paper due shortly?
- Central government has a leadership role and enforcement role as regards to local authorities. What mix of policies and administrative structures are currently in place or planned to enhance sustainability and adaptation? How are these policies monitored and evaluated as far as implementation?
- The Principal Officer of the Climate Change Policy Unit envisages that Ireland can strive towards an early mover society that demonstrates its understanding of transition mentality. In what way would you link this high-level strategic vision with local level implementation?
- Could you tell me a bit about the service indicators and how they are being used to increase local implementation? For example, the indicator for baseline greenhouse gas emission? How do these play out with the local authorities and what penalties/benefits are attached to them?
- How would you see central government encouraging administrative forums (e.g. cross-departmental climate change teams) within and among local authorities to enhance sustainability and climate adaptation?

- What other means would you see for striking balance between space for local innovations and overall standardisation?

Former Minister, Department of Heritage, Community and Local Government

Detailed questions were not prepared for this interview. The core themes identified for this interview were as follows:

- challenges regarding vertical and horizontal integration
- challenges making a transition from high-level strategies to practical implementation
- opportunities to move forward within the current framework
- opportunities that could be realised if there were greater support from the public and the elected officials