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Climate Resilient Places

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Lead organisation: University of Galway

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Rialtas na hÉireann
Government of Ireland

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2. Office of Environmental Enforcement
3. Office of Evidence and Assessment
4. Office of Radiation Protection and Environmental Monitoring
5. Office of Communications and Corporate Services

The EPA is assisted by advisory committees who meet regularly to discuss issues of concern and provide advice to the Board.

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Lead organisation: University of Limerick

What did the research aim to address?

This project aimed to address a key knowledge gap in how climate change – particularly rising flood risk – will affect Irish communities at a highly local level. More frequent and severe floods threaten sustainable development, deepen inequalities and strain housing, infrastructure and local services. At the same time, choices about where and how Ireland grows economically and spatially shape future exposure to climate hazards.

The project set out to generate detailed local evidence on future flood hazards and their potential costs, how people perceive and value these risks, and how existing planning, housing, mitigation and adaptation policies interact with community-level vulnerabilities.

The core research combines state-of-the-art methods across disciplines, including numerical flood modelling, estimation of local flood damage costs under climate change, econometric analysis of how property prices reflect flood risk and plot-level analysis of the relationship between planning decisions and exposure. The analysis leverages innovative big data techniques, machine learning and geographical information system analysis to create novel datasets that offer new insight into local-scale risks and support more climate resilient decision-making.

What did the research find?

The research reveals clear evidence that climate change is likely to intensify flood risks across Irish communities, including expanded floodplains and rising economic losses over time. New high-resolution modelling for Cork city illustrates the scale of possible future inundation under climate change, while estimates show that damage costs will escalate significantly without adaptation. Econometric analysis indicates that housing markets only partially reflect flood risk, suggesting that people and institutions may underestimate or undervalue future climate hazards. Analysis of planning decisions highlights similar gaps, with some development still occurring in areas likely to face increased exposure.

Stakeholder engagement – including interviews and surveys – revealed concern but varied perceptions of risk, reinforcing the need for clearer communication and support for local decision-making. The research advances the state of the art by integrating physical hazard modelling, economic analysis and social perspectives into a single evidence base. It also provides new datasets, methods and insights that can support national and local policy on adaptation, planning and community resilience.

How can the research findings be used?

The findings provide evidence to help policymakers, planners, communities and developers make decisions today that reduce future climate risks. Local-scale flood projections can inform land use planning, infrastructure investment and the design of adaptation measures. Economic estimates of flood damage and insights into housing market behaviour can support policies that better reflect risk in the planning system, insurance markets and housing strategies. Stakeholder feedback highlights the importance of engaging communities in conversations about resilience, trade-offs and long-term place-making.

Creating climate resilient places will require local efforts and investments. However, effecting change requires bringing people on board, connecting the science with people's everyday lived experiences and starting conversations about the difficult choices and trade-offs that will be faced. The concept of resilience has the potential here to act as a rallying call – as a focal point for a more positive, optimistic conversation about building climate resilient places and communities. The Climate Resilient Places research project aims to take the first steps in developing the evidence base and starting the conversations that will underpin the creation of climate resilient places in Ireland.

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Executive Summary

There is an urgent need globally, regionally and locally to identify climate resilient development pathways that integrate climate change mitigation and adaptation policies, together with other social, economic and environmental considerations. Climate change threatens to undermine sustainable development, while also reinforcing inequalities both locally and internationally. At the same time, particular patterns and forms of economic development will have a large bearing on attempts to mitigate climate change, while also altering exposure to current and future climate risk. This interplay between economic development and climate change is at the heart of the concept of climate resilient development. In this context, the overarching aim of this research project is to generate a significant step forward in our understanding of future risks related to climate change – specifically flood hazards – at a highly local level in Ireland; how these risks are perceived and valued; and how these risks interact with policies across a range of related sectors, including planning, climate change mitigation and adaptation, and community development.

The Climate Resilient Places research project aims to develop new evidence on the local impacts of climate change in Ireland, in the form of more frequent and more damaging floods. Changing weather patterns due to climate change mean that there is a need to prepare for and adapt to a future with more risk. Simultaneously, Ireland's population is growing despite a bourgeoning housing crisis, exacerbating demand for new residential development. The idea of climate resilience is to make decisions today that account for future risks from climate change, for example by ensuring that the homes, roads and other key infrastructure that are built today will not face repeated and costly flooding as risks intensify under climate change.

The core research of this project includes a range of state-of-the-art analyses across multiple disciplines: numerical flood risk modelling used to produce maps of inundation for Cork city under a range of scenarios; estimation of the local costs of flooding under climate change; econometric analysis of the extent to which flood risk is reflected in property prices in Ireland; and detailed analysis of the relationship between flood risk and planning decisions at the individual plot level.

The analysis leverages innovative use of big data, machine learning methods and geographical information system analysis to create novel datasets for the estimation of local costs and exposure to flood risk. The project also involved direct stakeholder engagement, including surveys and semi-structured interviews to better understand individual perceptions of and attitudes to risks related to climate change.

The research findings include new evidence on the potential impacts of climate change at the local level in Ireland in the form of the intensification of flood risks, expansion of existing floodplains and the potential for escalating costs of flooding over time. The project further investigates the extent to which current decisions in housing markets and the planning system reflect the risks from flooding.

Creating climate resilient places will require local efforts and investments. However, effecting change also requires bringing people on board, connecting the science with people's everyday lived experiences and starting conversations about the difficult choices and trade-offs that will need to be made. The concept of resilience has the potential here to act as a rallying call – as a focal point for a more positive, optimistic conversation about building climate resilient places and communities. The Climate Resilient Places research project aims to take the first steps in developing the evidence and starting the conversations that will underpin the creation of climate resilient places in Ireland.

This report presents an overview of some of the main findings and policy implications of the Climate Resilient Places research project, in a non-technical way for a generalist audience. The interested reader can find more information on all of the scientific outputs from the project at the project's web page: https://stories.universityofgalway.ie/climate-resilient-places.

1 The Resilience Approach to Adapting to Climate Change

1.1 Context: Climate Change is Already Happening, and We Need to Adapt

Anthropogenic, or human-induced, climate change is one of the greatest challenges of our time and a potentially existential threat to life as we know it on this planet. While the risks from climate change are likely to escalate, as warming continues we are already starting to see its effects on weather patterns around the world. Extreme and damaging weather events that were previously rare will increase in prevalence as the planet heats, and this process has already begun. Floods, wildfires, heatwaves, droughts and cyclones are already destructive and costly, and they are only becoming more severe and more frequent. The result is more and more people being exposed to these hazards and, ultimately, escalating costs of climate-related damage costs. The worst long-term effects of climate change may still be avoided through concerted global action to reduce greenhouse gas emissions and consequent global warming. However, greenhouse gases remain in the atmosphere for a long time, meaning that today's emissions will continue to warm the planet for years to come. Therefore, despite the potential for future reduction, historical emissions of greenhouse gases will have a lasting impact that we are only beginning to feel. As we continue to emit, we are committing to future warming and increased risks of extreme weather events. To manage these risks, and minimise the associated losses, we must learn to adapt to our changing climate.

The Irish government's Climate Action Plan 2021 outlines a target to "transition to a climate resilient, biodiversity rich and climate neutral economy no later than 2050".[1] Similarly, the EPA's stated view is that "Ireland must invest in structural and behavioural change to enable the transition to a climate neutral, climate-resilient country."[2] The climate resilient model is therefore very much a part of government plans for Ireland's future.

1.2 Project Objectives and Approach

In this context, the overarching aim of this research project is to generate a significant step forward in our understanding of future risks related to climate change – specifically flood hazards – at a highly local level in Ireland; how these risks are perceived and valued; and how these risks interact with policies across a range of related sectors, including planning, climate change mitigation and adaptation, and community development. The approach to achieving this aim will be informed by a resilience perspective on the challenge of adapting to climate change. The remainder of this chapter includes some reflection on the concept of resilience and a definition of climate resilient development.

1.3 Defining Climate Resilient Development

The first thing to note about climate resilient development is that it is a form of development; in other words, the primary objective of climate resilient development is to achieve some form of social or economic development. There can be no resilient development if we do not develop.

Climate resilience is a key objective of sustainable development. The aim of development is to improve the standard of living and well-being within a community, through economic and social change. For example, economic development may create jobs and improve wages within the community. Climate resilience is based on the idea that acknowledging and considering climate risk will ensure the longevity of our gains in these other areas.

1 https://assets.gov.ie/static/documents/climate-action-plan-2021-833aad8a-2afa-4894-9c6e-f2ff1f076c98.pdf (accessed 4 February 2026).

2 https://www.epa.ie/environment-and-you/climate-change/ (accessed 4 February 2026).

Resilience here refers to the capacity for self-preservation – that is, the capacity to cope with changing circumstances and recover from shocks. When it comes to climate resilient development, this refers to development that has the capacity to withstand the changing climate and associated hazards that we are now experiencing and will experience into the future.

1.3.1 Climate resilience and sustainability more broadly

Climate resilient development falls under the broader categories of sustainable development, green growth and climate smart development, as illustrated in Figure 1.1. Each of these development strategies incorporates environmental or climate-related objectives into the mainstream policy agenda of social and economic development.

Sustainable development is the broadest of these concepts and encompasses economic, social and environmental objectives – as captured by the United Nations 17 Sustainable Development Goals. An example of sustainable development is the creation of high-quality jobs that have broad-based benefits across groups in society and simultaneously avoid environmental damage. Green growth accounts for the environmental effects of economic growth and targets opportunities for growth that can be achieved while preserving nature; for example, a conservation programme that creates new jobs. Climate smart development involves efforts to develop in ways that do not rely on further greenhouse gas emissions and that also take account of the threats to development created by a changing climate. An example is incorporating the preservation of wetlands into development plans, to both reduce flood risk and act as a carbon sink. Climate resilient development is similar but refers specifically to managing the impacts of climate change through adaptation strategies, such that development gains are not eroded by the effects of a warming planet. An example is incorporating an early warning system into existing development plans or raising building heights. The core concept common to all these approaches is the development of something with the capacity for self-preservation.

Understanding where climate resilient development sits within these various approaches illustrates the specificity of the climate resilience objective: to develop in a manner that addresses and minimises the impact of climate change through adaptation and to make adaptation to climate risk a central part of mainstream economic and social policymaking. It is important to note that all these agendas exist under the banner of development and are therefore separate and distinct from more purely environmental agendas, such as the broader sustainability agenda, environmentalism and conservation movements.

1.3.2 Climate resilient development in practice – identifying trade-offs and co-benefits

At the local level, the development of a city or a community needs to incorporate multiple objectives across a range of policy areas and local

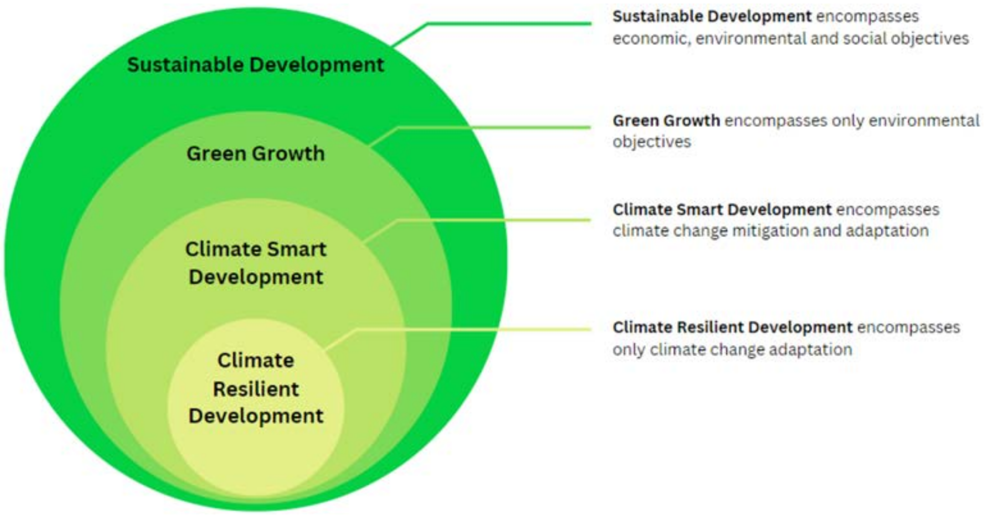

Figure 1.1. Diagram outlining the different approaches to development and the associated agendas. The definitions used here are based on the discussion in Fankhauser and McDermott (2016).

priorities. These may include population growth, accommodation, jobs, social cohesion, environmental objectives, and disaster risk management and adaptation. When the objectives of disaster risk management align with the objectives in other priority areas, we can refer to this as a co-benefit, for example when a flood management early warning system creates jobs in an area short of employment opportunities. However, when the objectives clash, there may be trade-offs between these different objectives (McDermott, 2016), for example when restrictions on new development in high-risk areas are at the expense of population growth.

Climate resilient development is therefore about finding ways to reconcile these trade-offs. A first step is to acknowledge and specify where trade-offs may occur, and to look for opportunities for co-benefits across agendas. Trade-offs and co-benefits with respect to development and climate resilience are discussed further in Chapters 3 and 4, for example in relation to the potential trade-off between compact urban growth and avoiding development in flood risk zones.

Although climate resilience and disaster risk management are often not a focal point of policymaking, they contribute to our vision for the future. Indeed, risk reduction is not a distinct goal in and of itself; some types of risk-taking, for example entrepreneurial risk-taking, research and development activities and innovation, are positive and to be encouraged rather than reduced. Rather, under the climate resilient model, considering climate risk adds another dimension to development plans. This includes opportunities for climate adaptation such as reducing vulnerability and exposure to climate-related disasters. Ultimately, the capacity of a community to manage extreme weather events can be built into existing and distinct development plans, strategies and investments, and the consideration of these possibilities is central to climate resilience. By estimating flood risk and damage costs across a range of different climate scenarios, the Climate Resilient Places research project provides new evidence that will help to inform this adaptation planning.

Climate resilient development mitigates climate-related disaster risk, while preventing or minimising the potential to lock in exposure. Development is climate resilient if it mitigates risk now, has a capacity to expand this ability in the future and is not only capable of but prepared for future adaptation (Reeder and Ranger, 2011).

1.4 Resilience as a Means of Coping with Uncertainty

There is significant uncertainty when it comes to climate change projections, but this does not justify delays in progress, or a “wait and see approach” to policymaking (McDermott, 2016). Rather, developing with a view to climate resilience, and incorporating flexibility and potential for change, can account for uncertain projections. At its core, climate resilience refers to the ability to cope with and mitigate the current risk of climate-related disasters and extreme weather events, while also being adaptable and flexible to future risks. This embeds a capacity to change under future conditions or projections. Climate resilience maximises effective adaptation by incorporating opportunity for change and future development.

Building in flexibility minimises the chances of maladaptation, which occurs when adaptation and development are poorly executed or inadequate (Reeder and Ranger, 2011). Maladaptation refers to measures that appear to reduce risk but are poorly suited to the risks of the future and can result in the emergence of new risks, for example the introduction of flood mitigation measures that protect some parts of a town but create worse flooding in other areas.

Beginning the adaptation process now, with the knowledge that predictions are unclear, allows us to build with a view to change. This prevents us from locking in our exposure to climate damage, as it minimises investment in high-risk solutions or areas. But getting started with this process requires local buy-in and community support.

1.5 The Need for Local Engagement and “Bottom-up” Approaches

There are a couple of key elements of community engagement that render it so crucial to climate resilient development. First, the uncertainty with which we estimate climate change projections accentuates differences within the community when it comes to how we understand and evaluate climate risks (McDermott, 2018). Engagement can improve our understanding of these various perspectives, and consequently improve our ability to find a solution. Second, to reach a consensus or agreement between stakeholders, engagement is critical, as it allows each group and individual to express how they interpret the risk and consequently what they believe is the appropriate course of action (McDermott and Surminski, 2018). Development is likely to progress more smoothly when stakeholders have been consulted and are kept informed through this transparent communication.

Bringing the community together through local engagement also introduces the potential for other benefits. It creates an opportunity for community members to work together to increase local capacity to find solutions and learn from each other. This process can create a shared understanding of risks and opportunities among the local community, policymakers, governments (local and national) and their agencies, facilitating social cohesion. Engagement provides locals with an opportunity to understand why others think and value what they do, and this is critical to understanding each other and connecting as a community. The community's input can also provide new ideas and solutions that are locally adapted, encompassing the knowledge that exists within the community. Additionally, the community can help developers or policymakers to understand the trade-offs that exist, and their prevalence. Following this, community engagement can be a means to weigh different agendas and determine how competing objectives should be accommodated. Finally, community engagement on climate resilience raises awareness of this method of development, and this can create a positive narrative, encouraging use of the climate resilient model for future projects and in other communities. Part of the research undertaken during the Climate Resilient Places project involved local stakeholder engagement aimed at improving our understanding of the perspectives and priorities of communities with respect to climate change, climate-related risks and building resilience to those risks.

2 Estimating Effects of Climate Change on Flood Risk and Costs of Flooding at the Local Level – Case Study of Cork City

2.1 Global Context

Flooding is already the most pervasive and costly natural disaster type globally. It is the leading cause of deaths resulting from natural disasters worldwide, with global estimates indicating that, on average each year, tens of thousands of people are killed, tens of millions are displaced and tens of billions of euros worth of damage is caused by flooding (Brakenridge, n.d.). Climate change is expected to make things worse in many locations, because of sea level rise, more intense rainfall patterns and potentially more intense storms (Dahl *et al*., 2017; Parker and Berardelli, 2019; Pörtner *et al*., 2019).

Alongside increasing risks from flooding, development in risky locations is increasing exposure to these risks. Currently, 1.8 billion people live in places exposed to flood risk worldwide (Rentschler *et al*., 2022). That number is rising due to rapid growth of coastal populations around the world (Rappaport and Sachs, 2003; Neumann *et al*., 2015; Rentschler *et al*., 2023) and continued new development in risky locations (Barrage and Furst, 2019; Lin *et al*., 2024). The combination of increased risk due to climate change and increased exposure due to development trends suggests potentially large increases in future costs of flooding. These global trends also apply in Ireland, where 40% of the population lives within 5 km of the coast, rising to over 60% in Cork (Doran *et al*., 2019).

Continued development in flood risk zones partly reflects the use of inadequate and outdated risk maps (Pralle, 2019; Bakkensen and Barrage, 2022; Wing *et al*., 2022). Generally, in many parts of the world, resources are not available to regularly produce and update risk maps at an official level, while official flood maps are typically mandated to be modelled on historical conditions – in other words, they do not reflect expected changes to risk. This context, and the need to plan for a future with increased risk, underscores the value of producing hyperlocal estimates of the potential damage from flooding in a world with climate change. Moreover, the focus here on local estimates enables the modelling to capture potential non-linearities and local extremes that may be missed in more aggregated analysis. This is particularly relevant in the context that is studied here (i.e. for a coastal city such as Cork city), given compound risks from fluvial and tidal flooding.

The research reported in this chapter involves estimates of the costs of flooding at the city scale for Cork city, Ireland, under both current conditions and a high-emission future climate scenario. The research leverages state-of-the-art flood hazard modelling, combined with detailed building-level data, to generate cost estimates. The procedure of generating cost estimates and the modelling approach were validated for a large flood event that occurred in Cork in 2009.

2.2 Local Context and Summary of Findings: Quantifying Future Costs of Flooding in Cork City

Flooding poses a significant threat to Cork. Cork Harbour is a shallow estuary, located at the mouth of the River Lee, where the sea level interacts with fluvial flows. The city has a long history of coastal flooding dominated by ocean and fluvial interactions. One notable example of such flooding occurred in November 2009. During this event, the River Lee experienced exceptionally high inflows, which coincided with high sea levels. As a result, the riverbanks were overtopped and even breached, causing extensive flooding throughout the city and its surrounding areas.

Climate change exacerbates the risks from both fluvial (river) flooding and coastal flooding by intensifying rainfall and contributing to sea level rise. This chapter presents the results of hyperlocal estimations of the increase in damage costs from flooding in Cork city under climate change. The findings suggest a potential 10-fold increase in the annual cost of flooding city-wide under a high-emission scenario. While climate change is expected to increase the frequency and intensity of flooding in areas that are currently considered at risk, a large proportion of the estimated increase in future flood costs is borne by areas that are currently considered relatively safe from flooding. The analysis lays bare the consequences of unabated climate change at the very local level in Ireland.

2.3 Methods

2.3.1 Mapping flood risk in Cork city

Maps of flood extents and depths for a range of return periods (RPs) under both current and future conditions were produced using state-of-the-art, extremely high-resolution hydrodynamic flood modelling for Cork city. The modelling approach employs joint probability analysis to take account of compound river and coastal flood risk. Elements of the hydrodynamic modelling approach employed here (including the Multi-Scale Nested Flood modelling system (MSN_Flood)) have been described in detail previously (see, for example, Nash and Hartnett, 2010), while comprehensive information on the model's parameterisation, sensitivity and validation are provided in Comer *et al.* (2017) and Olbert *et al.* (2017).

The model essentially takes river flows and sea levels as inputs and translates these into flooding extents and depths for every location in Cork city on a fine 2 × 2 m grid. For current conditions, fluvial and sea level drivers are defined based on the River Lee's flow (gauge station no. 19011) and mean sea level (MSL) information (Tivoli tidal gauge station). Examples of these data are illustrated in Figure 2.1.

Future flood risk was modelled for 2050 under the Shared Socioeconomic Pathway (SSP) 5-8.5 emission scenario. SSP5-8.5 represents rapid economic growth driven by fossil fuels and resulting in significant global warming by 2100. It thus provides an opportunity to study high-end or "extreme" future flood risk scenarios that are possible in a world without concerted climate action to reduce global emissions.

For future conditions, sea levels were taken from the Coastal Dataset for the Evaluation of Climate Impact (CoDEC), which provides data on extreme sea levels, tides and storm surges, including future

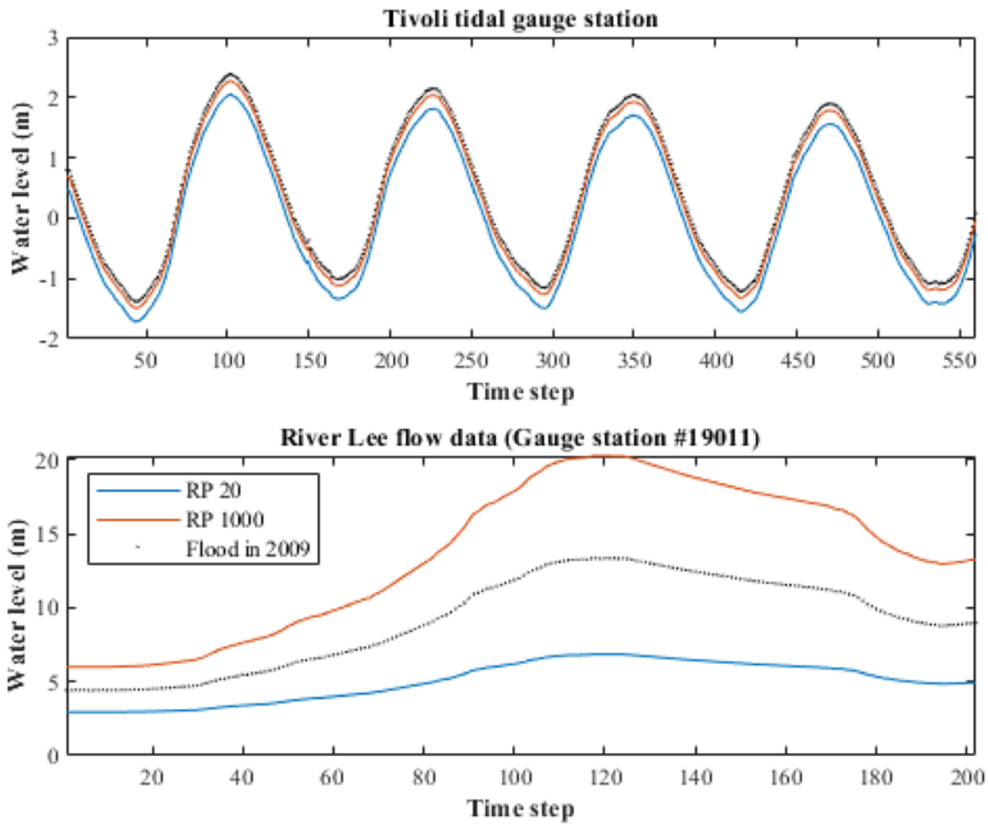

Figure 2.1. An example of input data for flood modelling in Cork city: Tivoli tidal gauge station data (top) and River Lee flow data (bottom).

projections under climate change (Muis *et al*., 2020). For fluvial flood modelling, surface run-off data from three different climate models from Coupled Model Intercomparison Project Phase 6 (CMIP6) were used (Wieners *et al*., 2019). These models were selected based on the availability of daily data, both historical and under SSP5-8.5. Using three different climate models enables model-based uncertainty to be explored; in other words, it enables the exploration of different interpretations of what a warmer world will mean for rainfall patterns.

Based on this approach, flooding was simulated for Cork city under current conditions for a set of six RPs (RP20, RP50, RP100, RP200, RP500 and RP1000). The model was also used to simulate the November 2009 flood event in Cork city using actual input data from that event (observed river flows and sea heights). Flooding under future conditions was simulated for five different RPs (RP20, RP50, RP100, RP200 and RP500) and three different climate models.[3] In total, 15 future flood risk simulations, 6 simulations for current scenarios and the simulation of the 2009 event were carried out – that is, 22 separate simulations of flooding for Cork city were produced. The resulting flood risk maps show predicted flood extent and depth on a 2 × 2 m grid for the entire city (a total of 1.3 million pixels), for each of the 22 scenarios modelled.

Further technical details on the flood modelling work can be found in the technical reports and scientific articles produced as part of the project, available through the project's web page: https://stories.universityofgalway.ie/climate-resilient-places.

Illustrations of the maps produced are available to view on the project's YouTube channel: https://www.youtube.com/watch?v=jR82Xg7FmAc.

Tables 2.1 and 2.2 show the values for river flow data (station no. 19011) and water level data (Tivoli station) that were used as the input data for the hydrodynamic model to predict coastal–fluvial flooding under different RPs for the study area.

2.3.2 Estimating damage costs and cost validation exercise

To estimate the potential damage costs associated with any given flood scenario for Cork city, the research involved essentially building a simulated city. First, it involved modelling how water flows through the city, for a given set of river flow and sea level inputs (as described above); next, flood maps were overlaid with detailed building-level data to estimate the depth of flood water at each individual building affected by a given flood scenario. Finally, simulated water depths and building information were combined with standard depth–damage cost coefficients to estimate the damage cost per building, which could then be aggregated to the small area or city level, to obtain the local or city-wide total cost per flood simulation.

Detailed information on building size and type is needed to estimate flood damage. In this study, the most granular level of building data available was used to estimate building size and classification (residential detached, commercial office/retail, etc.). The main data sources included PRIME2 OSi (the highest-resolution

Table 2.1. River flow data under different RPs

		Calculated river flow (m³/s)		
RP (years)	River flow (m³/s)	MPI-ESM1-2-LR EVA	Nor-ESM2-LM EVA	Nor-ESM2-MM EVA
20	406.10	690.03	636.20	839.00
50	482.98	943.85	908.66	1187.10
100	541.49	1134.10	1112.80	1447.90
200	600.57	1323.60	1316.30	1707.80
500	679.71	1573.60	1584.60	2050.60

EVA, extreme value analysis.

3 MPI-ESM1-2-LR, Nor-ESM2-LM and Nor-ESM2-MM.

Table 2.2. Water level data under different RPs

RP (years)	Tide and surge (MSL (m))	Calculated water level (m) from CoDEC
20	2.44	0.805
50	2.51	0.907
100	2.57	0.974
200	2.61	1.018
500	2.67	1.080

building polygon data available for Ireland), Eircodes (individual addresses indicating if the building is residential or commercial) and listings on the Daft.ie property website (which identify the type of residential dwelling (detached, apartment, etc.) or commercial property (retail, office, warehouse, etc.)). Standard depth–damage coefficients (by building type) were obtained from the Multi-Coloured Manual (Penning-Rowsell, 2013), with adjustments made in line with Office of Public Works (OPW) guidance (OPW, 2023).

Before proceeding to estimate the costs of future flood events under climate change, we first report the findings from a cost validation exercise for the 2009 flood event in Cork. This validation exercise enables us to understand if the procedure employed returns reasonable estimates of damage costs from historical flood events. Engineering work had previously validated the flood modelling with reference to the 2009 flood event in terms of both depths and extents (see Olbert *et al*., 2017). Official figures put the estimated damage costs from the 2009 flood at €90 million (OPW, 2017). That is equivalent to €114 million in 2024. The simulated flood event and cost estimation procedure returned a damage cost estimate of €104 million (with a 95% confidence interval of €96 million to €120 million). The 95% confidence interval here accounts for the uncertainty in the estimated flood water depth at any given location in the city and is based on the flood depth validation exercise reported in Olbert *et al*., 2017. This exercise provided reassurance that the modelling approach employed – in terms of both the modelling of flood extent and depths, and the procedure for translating these into estimated damage costs – can return reasonable estimates of flood damage costs. The next section reports the results of damage cost estimates from the full range of simulated flood scenarios for Cork city.

2.4 Results

2.4.1 Summary of findings

The research presented here quantifies the potential impacts of climate change at the hyperlocal level, with flooding mapped on a 2 × 2 m grid, and damage costs estimated on a building-by-building basis. The nature of the analysis also allowed us to explore extremes and account for uncertainties. Under a high-emission scenario (SSP5-8.5), the modelling estimates indicate that the average annual loss (AAL) from flooding in Cork could rise from an estimated €18 million under current conditions to €187 million by 2050 (2023 euro estimates). This 10-fold increase underscores the urgent need for adaptive policy measures to protect lives, infrastructure and the economy. The high-resolution flood modelling also demonstrates that climate-induced flooding is likely to impact areas previously deemed low risk, thereby expanding the city's floodplain.

2.4.2 Aggregate losses for the city, for each of the simulated flood scenarios

Table 2.3 and Figure 2.2 present estimates of total direct costs of damage to residential and commercial property for each of the 22 modelled flood scenarios for Cork city: six scenarios (RPs) under current climate conditions, 15 scenarios (five RPs for three different climate models) for future conditions and the 2009 event scenario. The results illustrate the very large increases in estimated damage costs from flooding across all RPs – that is, for both relatively high-frequency flood events and rarer or "more extreme" events.

Taking the 2009 event as a benchmark for comparison, the results in Table 2.3 suggest that, by 2050, a flood with a likelihood (or RP)[4] similar to the one in 2009 could result in damage costs that are roughly four to seven times higher. Alternatively, looking at the damage cost estimates in Figure 2.2, it is clear that flood events even more damaging than the 2009 event

4 The 2009 event had an estimated RP of approximately 160 years. We therefore compare it with future floods with an RP of 100 to 200 years (RP100 and RP200 simulations).

Table 2.3. Estimates of total direct damage costs to residential and commercial property for each of the 22 modelled flood scenarios for Cork city

RP	Model	Total costs
RP20	Current scenario	€17,622,693
	GEV-NorESM2-LM	€272,322,596
	GEV-MPI-ESM1-2-LR	€184,915,107
	GEV-NorESM2-MM	€371,732,423
RP50	Current scenario	€27,390,628
	GEV-NorESM2-LM	€318,175,369
	GEV-MPI-ESM1-2-LR	€362,289,396
	GEV-NorESM2-MM	€456,979,699
RP100	Current scenario	€64,224,017
	GEV-NorESM2-LM	€445,515,106
	GEV-MPI-ESM1-2-LR	€511,080,448
	GEV-NorESM2-MM	€644,515,133
RP200	Current scenario	€158,341,496
	GEV-NorESM2-LM	€586,784,261
	GEV-MPI-ESM1-2-LR	€647,782,462
	GEV-NorESM2-MM	€757,521,473
RP500	Current scenario	€249,478,197
	GEV-NorESM2-LM	€954,136,835
	GEV-MPI-ESM1-2-LR[a]	€954,136,835
	GEV-NorESM2-MM	€1,145,452,260
RP1000	Current scenario	€288,882,322
2009 flood	Current scenario	€104,489,256

Note: 2023 euro values are used.

[a]Due to computational constraints, specifically the hydrodynamic model being unable to complete the run for the GEV-MPI-ESM1-2-LR-RP500 model, a substitute was required to maintain the analysis. The results for GEV-NorESM2-LM-RP500 were utilised instead to approximate the required river flow, resulting in a negligible decrease in prediction accuracy of less than 0.5–1%. The original target river flow was 1573.6 m^3/s, while the substituted model's river flow was 1584.6 m^3/s.

GEV, generalised extreme value theory.

would be expected to occur every 20 years under the high-emission scenario that is modelled here; all three damage cost estimates for the future RP20 (for the three different climate models) are considerably higher than the estimated damage costs from the 2009 flood (presented in the last bar on the right of the figure).

2.4.3 Average annual loss for the city

AAL represents the average damage costs that flooding is expected to incur annually. It is a standardised measure that considers multiple RPs and hence accounts for both frequent minor floods and rare major floods. Calculating AALs therefore involves using information from each simulated flood scenario – across all the modelled RPs under current climate conditions, and again across all the modelled RPs under future climate conditions (repeated here for the three different versions of the future climate, based on the three climate models considered). As shown in Table 2.4 and Figure 2.3, direct residential and commercial damage costs from flooding could increase more than 10-fold by 2050 under a high-emission scenario. Looking at the breakdown between commercial and residential damage costs, floods in Cork city tend to be concentrated in the central business district; hence, commercial damage costs are far greater than residential damage costs for a given flood simulation (see results in Table 2.4 and Figure 2.3).

In addition to the direct costs of damage to residential and commercial property that are estimated using the modelling procedure outlined previously, floods are also likely to cause additional costs in the form of intangible losses (disruptions to people's everyday lives, stress, anxiety and illness) and indirect costs such as traffic disruption, increased burden on emergency services and damage to utilities. These additional costs can be approximated as a proportion of the observed (or estimated/modelled) direct damage costs, based on historical experience. Table 2.5 presents estimates of these intangible and indirect costs, following the methods employed in the OPW's Lower Lee Flood Relief Scheme options report (OPW, 2017) both for the current scenario and under future climate conditions. As shown in Table 2.5, the total AAL for Cork – taking account of direct, intangible and indirect costs – is estimated to increase from €18 million under current climate conditions to €187 million under future climate conditions for a high-emission scenario.

2.4.4 Mapping results by small area, and intensive versus extensive margin comparison

The previous sections have presented aggregated losses for Cork city – first for each of the 22 individual flood scenarios modelled, and then combining these to calculate AALs for both current and future climate conditions. Given the granularity of the modelling work, it is also possible to disaggregate the damage

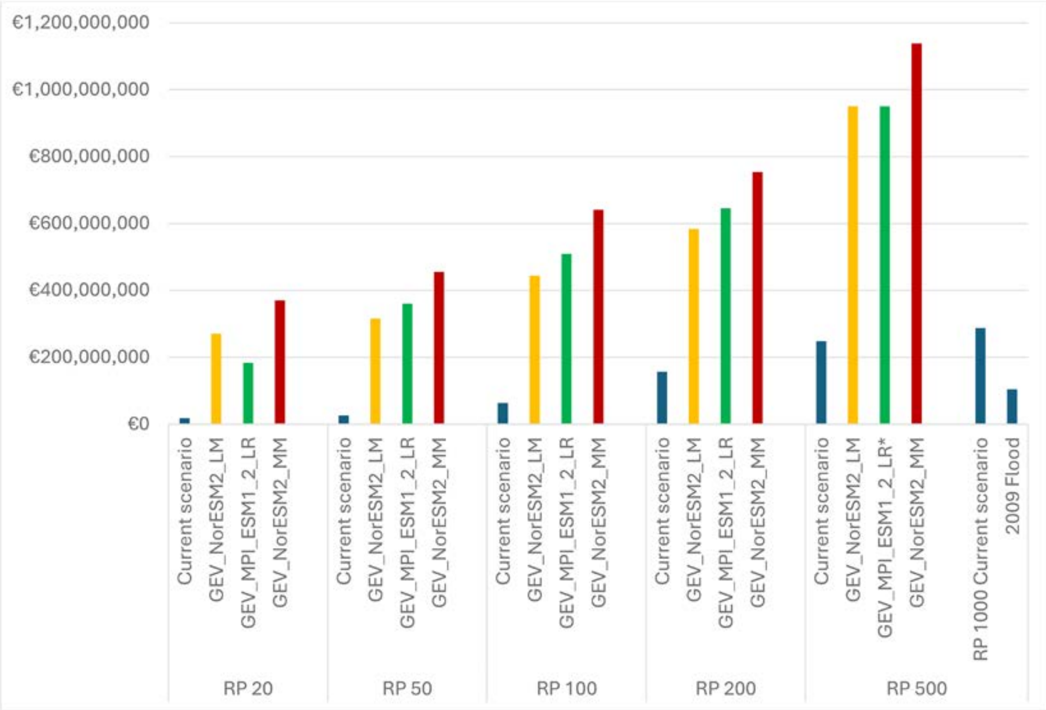

Figure 2.2. Estimates of total direct damage costs to residential and commercial property for each of the 22 modelled flood scenarios for Cork city. 2023 euro values are used. *Due to computational constraints, specifically the hydrodynamic model being unable to complete the run for the GEV-MPI-ESM1-2-LR-RP500 model, a substitute was required to maintain the analysis. The results for GEV-NorESM2-LM-RP500 were utilised instead to approximate the required discharge, resulting in a negligible decrease in prediction accuracy of less than 0.5–1%. The original target discharge was 1573.6 m^3/s, while the substituted model's discharge was 1584.6 m^3/s. GEV, generalised extreme value theory.

Table 2.4. Estimates of AALs for the current scenario and for each of the three versions of the future scenario in 2050 (rows 2–4), broken down by residential, commercial and total damage costs

Model	Residential	Commercial	Total
Current scenario	€771,292	€11,010,446	€11,781,738
GEV-NorESM2-LM	€7,628,540	€111,369,560	€118,998,100
GEV-MPI-ESM1-2-LR[a]	€7,982,809	€110,478,800	€118,461,609
GEV-NorESM2-MM	€12,255,412	€155,276,160	€167,531,572

[a]Due to computational constraints, specifically the hydrodynamic model being unable to complete the run for the GEV-MPI-ESM1-2-LR-RP500 model, a substitute was required to maintain the analysis. The results for GEV-NorESM2-LM-RP500 were utilised instead to approximate the required discharge, resulting in a negligible decrease in prediction accuracy of less than 0.5–1%. The original target discharge was 1573.6 m^3/s, while the substituted model's discharge was 1584.6 m^3/s.

GEV, generalised extreme value theory.

estimates in various ways. For example, damage estimates can also be produced at the small area level. Small areas represent the lowest geographical level for the compilation of statistics from census data in Ireland. They typically contain between 50 and 200 dwellings and generally comprise either complete townlands or neighbourhoods (CSO, 2022).

The maps presented in Figures 2.4 and 2.5 illustrate how the costs of flooding are distributed across the city. Figure 2.4 shows estimated AALs per small area (2023 euro values) under current conditions (top panel) and future conditions (bottom panel). Comparing the two maps, an intensification of flood damage costs under climate change for areas adjacent to the River Lee, and especially in the city centre, is apparent.

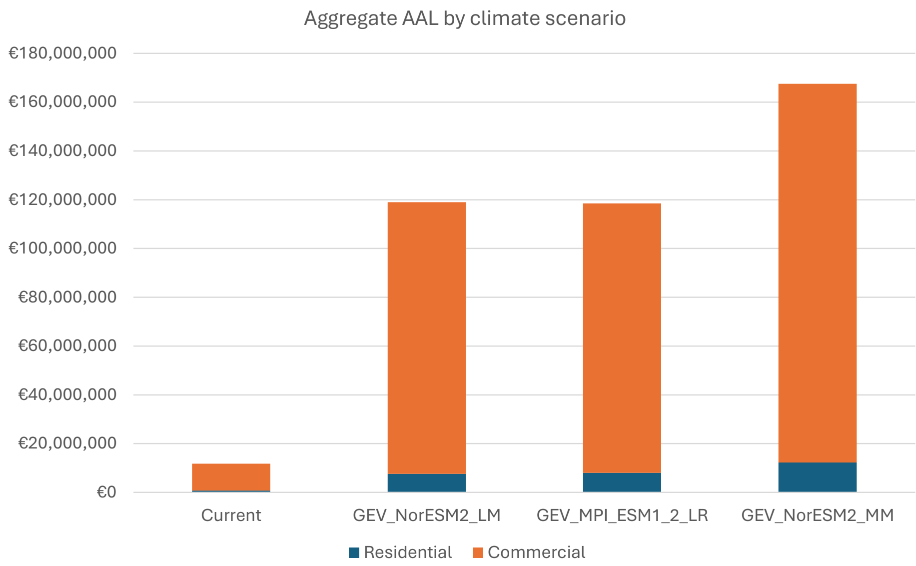

Figure 2.3. Estimated direct residential and commercial damage costs for current and (three separate versions of) future climate conditions. GEV, generalised extreme value theory.

Table 2.5. Estimates of the total annual costs of flooding, accounting for intangible and indirect losses, on top of the directly estimated direct residential and direct commercial damage costs reported previously

Cost	Current scenario	Future scenario (2050)
Direct residential	€771,292	€7,982,809
Direct commercial	€11,010,446	€110,478,800
Intangible residential	€771,292	€7,982,809
Intangible commercial	€2,202,089	€22,095,760
Traffic, at 5% of PDD	€589,087	€5,923,080
Emergency services, at 8.1% of PDD	€954,321	€9,595,390
Utilities, at 20% of PDD	€2,356,348	€23,692,322
Total	**€18,654,874**	**€187,750,971**

Note: The intangible and indirect costs are modelled as a fixed proportion of the direct damage costs, in line with methods employed by the OPW in the Lower Lee Flood Relief Scheme options report. The future scenario presented here is based on results using the GEV-MPI-ESM1-2-LR climate model. PDD, private direct damage costs (the sum of direct residential and direct commercial damage costs).

One particularly policy-relevant consideration in terms of where future damage costs will occur within the city is the estimated change in damage costs on the intensive and extensive margins. In other words, it is important to consider how much of the estimated increase in flood damage costs is due to more frequent or intense flooding of places already considered at risk under current conditions, and how much is due to future flooding occurring in places that are currently deemed relatively safe.

To approximate this, a distinction can be made between places that currently seem low risk (i.e. those that would be unaffected by a so-called 1-in-100-year event under current climate conditions) and those considered higher risk (i.e. those that would be expected to be flooded by that same event (with RP100 generally being applied to a floodplain)). Based on this distinction, and taking the estimated total direct damage costs from row 3 of Table 2.4, of the €107 million increase in AAL between now and 2050, €38 million of that increase will be accounted for by buildings already at risk, whereas €68 million will be borne by buildings not currently deemed at risk. That is, almost two-thirds of the estimated increase in direct damage costs from flooding under climate change will occur on the extensive margin, or in other

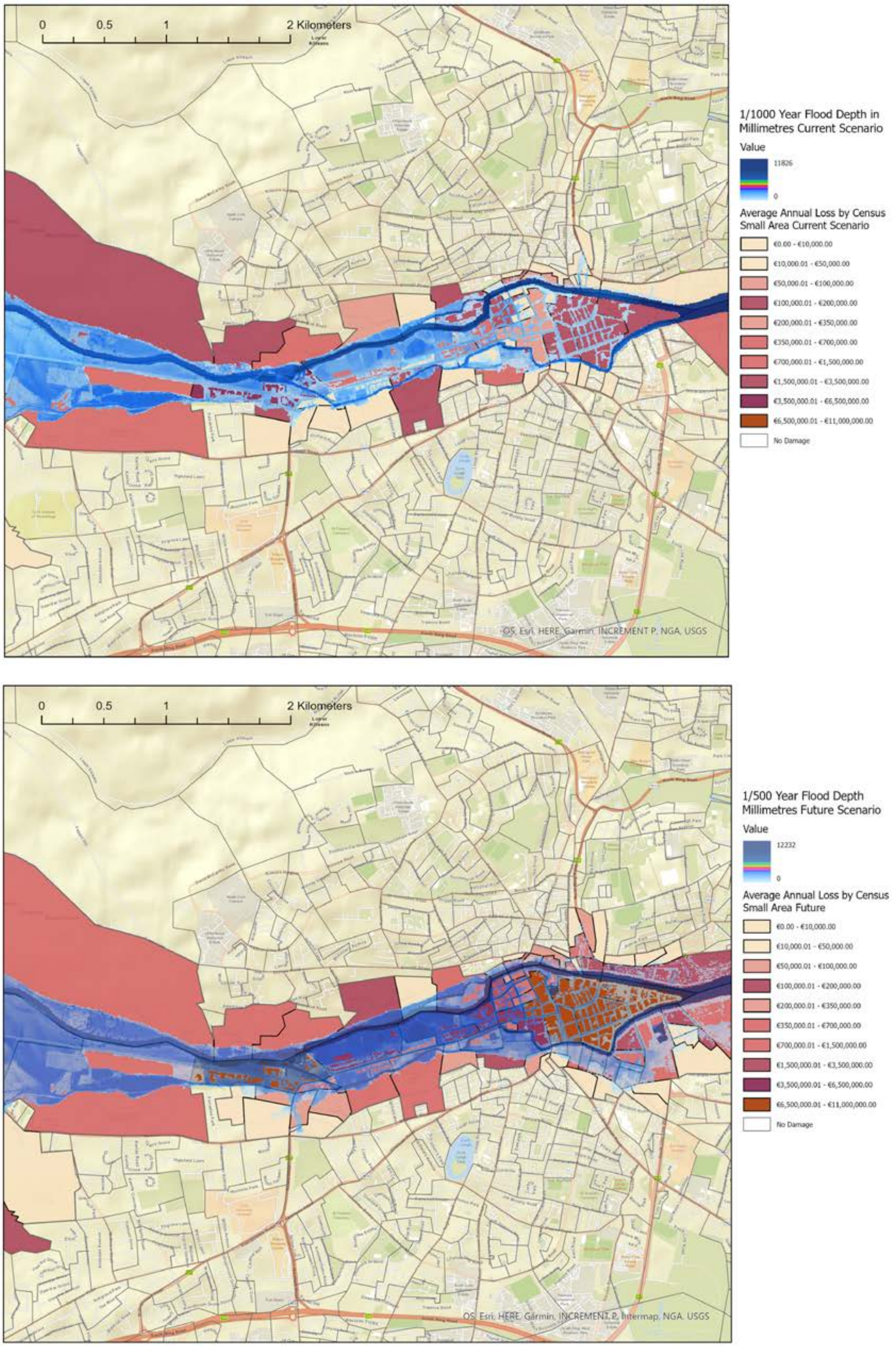

Figure 2.4. Estimated AALs per small area (in 2023 euro values) under current conditions (top panel) and future conditions (bottom panel). Each map includes a flood scenario overlaid in blue for illustration. Comparison of the two maps underscores the intensification of flood damage costs for areas adjacent to the River Lee, and especially in the city centre, under climate change. Sources: OS, Esri, HERE, Garmin, INCREMENT P, Intermap, NGA and USGS. This map was created using ArcGIS software by Esri. ArcGIS and ArcMap are the intellectual property of Esri and are used herein under licence. Copyright © Esri. All rights reserved. For more information about Esri software, please visit www.esri.com.

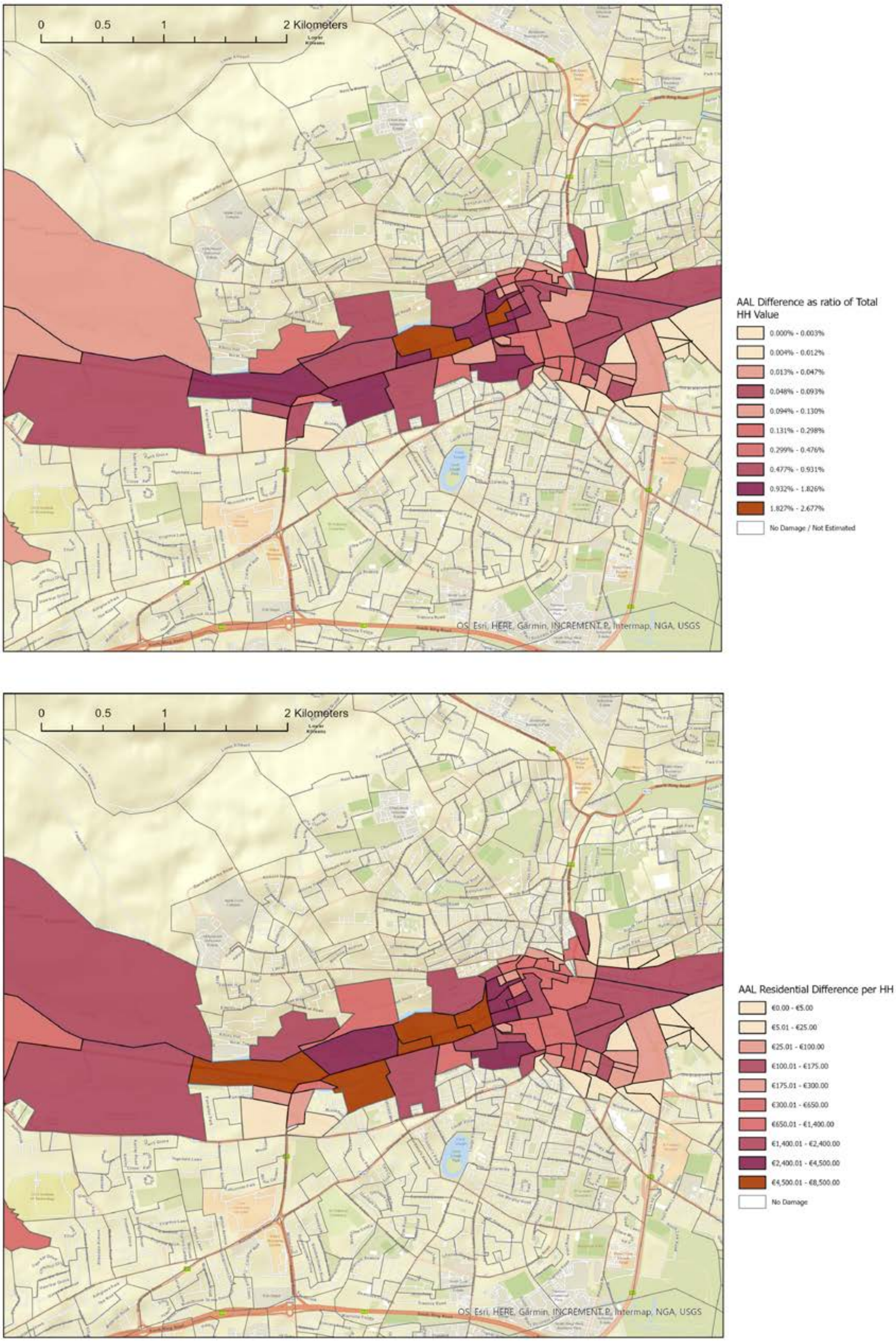

Figure 2.5. Change in estimated residential damage costs under climate change at the local level. In the top panel, the map depicts the change in estimated residential damage costs relative to the value of the housing stock in each small area. In the bottom panel, the map depicts the change in residential damage costs per household at the small area level. HH, household. Sources: OS, Esri, HERE, Garmin, INCREMENT P, Intermap, NGA and USGS. These maps were created using ArcGIS software by Esri. ArcGIS and ArcMap are the intellectual property of Esri and are used herein under licence. Copyright © Esri. All rights reserved.

words in places not currently considered at risk. While climate change is expected to intensify the risks for places that already experience regular flooding, it will also create new risks for places that had previously been considered relatively safe, expanding the city's floodplain.

2.5 Conclusions

Reinstatement of property and infrastructure after flood damage is already extremely costly. The evidence presented here suggests that those costs could rise 10-fold by 2050 under a high-emission scenario. This new evidence on the local impacts of climate change has important policy implications. For example, in relation to mitigation, this study illustrates the costs of climate change at the very local level in Ireland. In terms of adaptation, the results highlight the need to account for increased future risk in any adaptive strategies or investments that are made today. Finally, for local (spatial) planning and investment, the research presented here highlights that some areas that appear relatively safe from flooding today could be at risk in the (near) future. Myopic investments and planning decisions today increase exposure to, and ultimately costs associated with, flooding in the future.

3 Flood Risk and Urban Development Trends

3.1 Background

The previous chapter illustrated the potential increase in flood risk (extents and depths) and impacts (costs) under future climate change. The analysis imposed future flood risk maps on a static urban environment – that is, where the buildings remain fixed. In reality, urban areas are dynamic – they experience growth and decline over time, changing their spatial extents, structures and shapes, with consequences for the assets and populations exposed to flood risk. Globally, areas experiencing the fastest rates of population growth and associated urban expansion are also some of the places most exposed to flood risk, both currently and in terms of anticipated future increases in that risk. In this chapter, the research presented examines different approaches to quantifying current exposure to flood risk and how urban areas have developed over time with respect to risk. The research also tests the extent to which planning decisions in Ireland over recent years reflect policy guidance on avoiding new development in flood-prone areas.

3.2 Documenting Urban Development Patterns Over Time

The analysis presented previously demonstrated that, in a future under climate change, flood risk in Cork city is going to increase, potentially by a substantial amount. The challenges this analysis highlights for Cork are also likely to be relevant for many low-lying coastal cities around the world, including other coastal settlements in Ireland.

Historically, Cork city has grown from the urban core outwards, in line with standard models of urban growth (see Figure 3.1). Exposure to flood risk in the city reflects these spatial development patterns, with much of that exposure being determined by the location of the historical urban core. Development into the urban hinterland and suburbs has generally been away from the riskiest areas in terms of flooding, albeit with some notable exceptions (e.g. Blackpool). However, the mapping of future flood risk and associated damage costs in the previous chapter also illustrated that the character and the location of flood risk will change in a warmer world. For example, almost two-thirds of the estimated increase in damage costs relates to locations that are currently not expected to flood even in a 1-in-100-year event – that is, places that would generally be viewed as not at risk from flooding today.

3.2.1 Potential trade-offs: sustainable versus climate resilient urban development

Planning documents regularly refer to the need to pursue "compact" urban development as a more sustainable form of urbanisation (see, for example, the Cork City Development Plan 2022–2028 (Cork City Council, 2022)). However, for low-lying coastal cities such as Cork city, this means intensification of development within the existing urban core, where risks from flooding are most pronounced (under current conditions) and expected to increase significantly in the coming decades under climate change.

Compact urban development is a worthy goal. Similarly, avoiding building in floodplains is necessary to avoid escalating costs resulting from urban floods. These two goals are regularly cited, independently, in policy documents. But rarely is the potential trade-off between the two made explicit. Climate change will increase flood risk in most places, perhaps significantly. At the same time, continued population growth and spatial development patterns (urbanisation) mean that the demand for urban housing is growing rapidly. Many cities – including Cork city – need to rapidly build many more homes. How to accommodate all this new development, in places that are geographically constrained, and in a way that aligns with sustainability objectives (e.g. compact growth strategies) but still avoids development on flood-prone land, represents a considerable challenge for planners and policymakers. As risks increase, and available "safe" areas for development within existing city footprints become scarce, city planners will face increasingly hard choices. A further issue for city planners, not examined here, is that new development often results in increases in the extent of hard surfaces, exacerbating the risks from pluvial flooding.

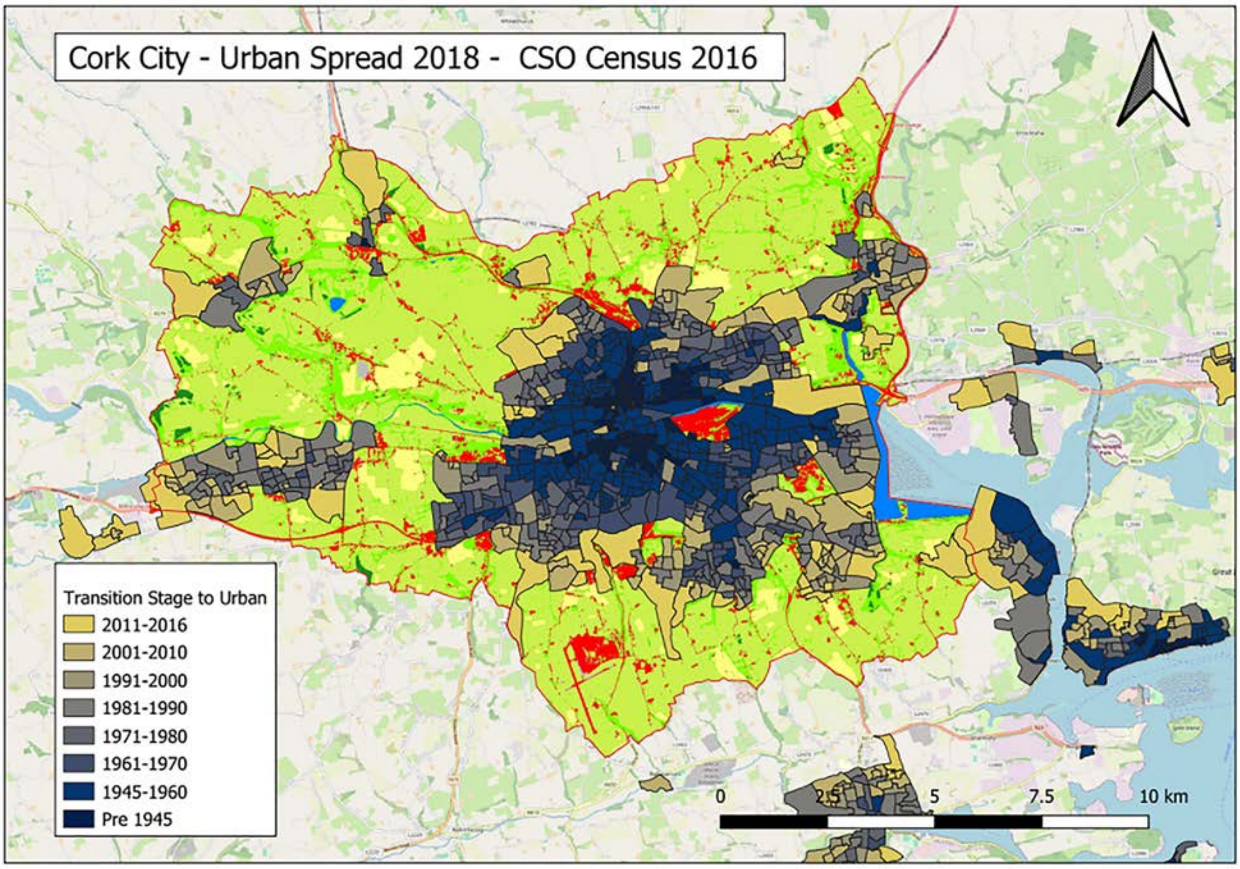

Figure 3.1. The expansion of Cork city's urban environment over time, based on small area data from the 2016 census on year of construction of housing units. Each small area is defined here as having become "urbanised" based on the earliest date that housing density exceeds at least one housing unit per hectare. Census housing data at the small area level are overlaid on a map of urban extents (in red, 10 m resolution) based on Coordination of Information on the Environment (CORINE) land cover data for 2018. CSO, Central Statistics Office. This map was created using ArcGIS software by Esri. ArcGIS and ArcMap are the intellectual property of Esri and are used herein under licence. Copyright © Esri. All rights reserved.

3.3 Flood Risk and Planning Permission in Ireland

Given the substantial costs associated with flood events, and the very significant ongoing public investment in flood relief schemes, the following policy questions are important:

- To what extent does development policy at the local level follow the national guidelines in terms of avoiding new development in flood-prone areas?
- Does development policy give due consideration to flood risk?
- Is housing delivery being prioritised over scientifically assessed risk in the context of an increased population and housing supply pressure?

3.3.1 Data and methods

Data on the universe of planning applications in Ireland (2014–2022) were obtained from the National Planning Application Database (NPAD) – a dataset that includes hundreds of thousands of individual planning applications from around the country. The NPAD includes geographical coordinates for each application. Combining these data with flood risk maps from the OPW enabled each planning application to be categorised according to its official flood risk status. The NPAD includes a range of relevant variables, including, most notably, the decision (granted, refused or other). Text mining, leveraging artificial intelligence/machine learning techniques, was used to extract further relevant information from the description of each planning application. Of particular importance for this research was the type of application (e.g. extension, retention or new development) and the number of units included in each application. The focus of this research was on new residential development applications. With these data, it was possible to account for the number and proportion of new residential applications where planning permission in flood risk zones was granted or refused, relative to other areas around the country.

3.3.2 Results part 1 – quantifying new development in flood risk zones

The research identifies some 10,000 new residential housing units that were granted planning permission in flood risk zones around Ireland between 2016 and 2022 (see Table 3.1). These are split roughly 60:40 between "low" risk zones (where the scientifically assessed probability of flooding is 0.1–1% per year), which account for almost 6000 of the new units granted permission, and "medium" risk zones (where the assessed probability of flooding is 1–10% per year), which account for the remaining 4000 units.

An important question here is whether the rate of new development in risky areas has slowed or accelerated over time. To get a handle on this, it is possible to compare the stock of "risky" housing units against the flow of new permissions granted in risky areas. The stock can be represented using Eircodes data (from 2022). The research found that 3.1% of Eircodes are in low-risk areas and a further 1.3% are in medium-risk areas. This represents the effect of historical decisions about where to allow development on exposure to flood risk today. Turning to the flow of new development, approximately 158,000 new housing units were granted planning permission in Ireland during the period under study. Of these, 3.7% were in low-risk zones (compared with 3.1% of the stock) and 2.5% were in medium-risk zones (compared with 1.3% of the stock). Comparing the stock with the flow, the research shows that the rate of development being allowed in risky areas has accelerated if anything in recent times, and this trend is most pronounced in medium-risk (rather than low-risk) zones.

3.3.3 Results part 2 – the effect of flood risk on planning decisions depends on local housing pressure

The results reported above notwithstanding, it remains the case that refusal rates are higher for applications in flood risk zones than elsewhere. The average proportion of applications being granted permission is around 70% for risky areas, compared with 80% elsewhere. A more systematic analysis of the data – using regression techniques to control for factors such as the number of units per application, proximity to the nearest central business district (or town centre), the individual local authority and a six-category rural/urban designation for the type of area the application was being made in – also shows that applications in medium-risk areas are roughly 25% more likely to be rejected.

These results suggest that planning guidelines to avoid new development in flood risk zones are being implemented, at least in some cases. To further understand the circumstances under which "risky" applications are likely to be rejected, the research looked at the effect of flood risk on planning decisions across the six rural/urban categories used by the Central Statistics Office (see Figure 3.2). The results suggest that, in cities and satellite urban towns, flood risk does not exert a significant influence on the likelihood of a planning application being rejected.

These results indicate that, in more urban areas, flood risk is somehow less salient in planning decisions. This might reflect competing policy goals, as outlined previously in terms of the desire to foster compact urban growth conflicting with the guidance to avoid new development in flood risk zones. It could also reflect different pressures and economic realities in urban and rural areas; for example, as housing demand (and price pressure) is more pronounced in urban areas and land available for development is scarcer, this limits the options for new development in non-risky locations.

To directly test the housing pressure hypothesis, a local housing price pressure index was generated, based on data from Daft.ie on the growth in list prices from 2013 to 2016, and accounting for dwelling characteristics of the properties listed in that period (i.e. a mix-adjusted index). A relative measure of house price pressure was generated at the electoral division level, separately for each local authority area in the country, to create an index that reflects local price pressures. This index is illustrated in Figure 3.3.

The analysis then tested the extent to which the likelihood of a new residential planning application being refused varies according to the intensity of the

Table 3.1. Quantifying planning applications according to the outcome (granted or refused) and the level of flood risk (“no”, “low” or “medium”), by local authority area

	Total units			No-risk units			Low-risk units			Medium-risk units		
Council	Granted, *n*	Refused, *n*	Granted, %	Granted, *n*	Refused, *n*	Granted, %	Granted, *n*	Refused, *n*	Granted, %	Granted, *n*	Refused, *n*	Granted, %
Carlow County	1252	303	80.5	1218	239	83.6	44	27	62.0	27	24	52.9
Cavan County	1811	160	91.9	1808	160	91.9	8	0	100.0	5	0	100.0
Clare County	3551	276	92.8	3414	271	92.6	186	6	96.9	139	5	96.5
Cork City	8329	1486	84.9	8106	1420	85.1	286	80	78.1	191	61	75.8
Cork County	17,885	2917	86.0	17,770	2837	86.2	201	117	63.2	164	116	58.6
Donegal County	4742	546	89.7	4702	525	90.0	80	22	78.4	45	0	100.0
Dublin City	22,377	7857	74.0	19,999	7200	73.5	2594	889	74.5	1970	403	83.0
Dún Laoghaire–Rathdown County	6387	2619	70.9	6386	2589	71.2	533	41	92.9	528	15	97.2
Fingal County	7277	2795	72.2	7256	2771	72.4	24	67	26.4	11	16	40.7
Galway City	2500	418	85.7	2491	417	85.7	49	1	98.0	2	0	100.0
Galway County	4505	2560	63.8	4463	2381	65.2	62	197	23.9	46	33	58.2
Kerry County	3009	524	85.2	2960	518	85.1	61	13	82.4	34	13	72.3
Kildare County	9957	4037	71.2	9904	3758	72.5	79	337	19.0	30	310	8.8
Kilkenny County	3103	575	84.4	3058	562	84.5	148	15	90.8	53	11	82.8
Laois County	4471	160	96.5	4448	158	96.6	58	4	93.5	23	1	95.8
Leitrim County	383	12	97.0	379	11	97.2	5	1	83.3	4	1	80.0
Limerick County	5988	706	89.5	5876	518	91.9	125	188	39.9	59	32	64.8
Longford County	1231	236	83.9	1205	236	83.6	32	0	100.0	31	0	100.0
Louth County	9157	845	91.6	8813	771	92.0	753	74	91.1	364	7	98.1
Mayo County	3223	523	86.0	3199	515	86.1	34	13	72.3	23	12	65.7
Meath County	14,041	2612	84.3	13,917	2225	86.2	132	445	22.9	111	387	22.3
Monaghan County	1084	76	93.4	1067	75	93.4	18	1	94.7	0	1	0.0
Offaly County	1318	187	87.6	1311	183	87.8	19	5	79.2	2	2	50.0
Roscommon County	975	435	69.1	973	433	69.2	7	3	70.0	1	0	100.0
Sligo County	609	44	93.3	609	44	93.3	0	0	–	0	0	–
South Dublin County	960	391	71.1	943	384	71.1	22	30	42.3	13	23	36.1
Tipperary County	1408	259	84.5	1402	258	84.5	7	2	77.8	5	0	100.0
Waterford City & County	3495	984	78.0	3489	932	78.9	11	55	16.7	7	55	11.3
Westmeath County	2185	498	81.4	2181	497	81.4	29	7	80.6	25	6	80.6
Wexford County	3888	1374	73.9	3751	1373	73.2	147	1	99.3	10	1	90.9
Wicklow County	6560	2200	74.9	6449	2195	74.6	120	26	82.2	84	21	80.0
Total[a]	157,661	38,615	80.3	153,547	36,456	80.8	5874	2667	68.8	4007	1556	72.0

[a]Of all planning applications, 4.4% were for units in low-risk areas and 2.8% were for units in medium-risk areas. Of all planning applications granted, 3.7% were for units in low-risk areas and 2.5% were for units in medium-risk areas.

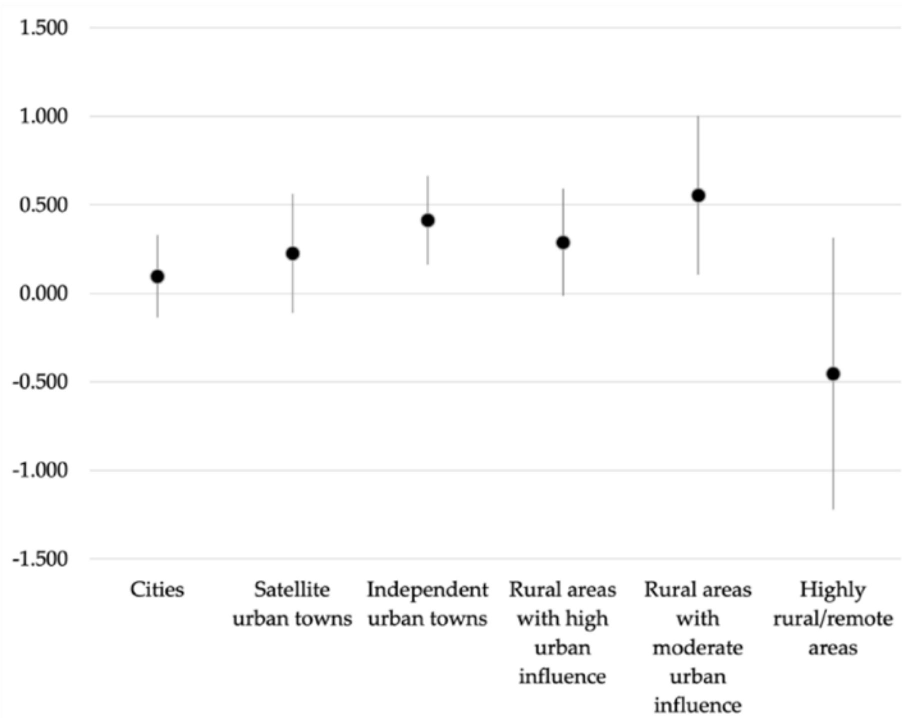

Figure 3.2. Estimates of the effect of being in a medium-risk flood zone on the probability of a new residential planning application being rejected. Positive values indicate a higher likelihood of a planning application being rejected in that type of area.

local price pressure index. The findings are illustrated in Figures 3.4 and 3.5, showing that, while applications are more likely to be rejected in medium-risk flood zones across most of the sample, in areas with high price pressure (an index value more than 1 standard deviation above the mean) flood risk does not have a statistically significant effect on the planning outcome.

Areas with a high level of price pressure are illustrated in Figure 3.5 and clearly correspond to the main commuter belt zones and the environs of major towns and urban areas around the country.

3.4 Conclusions and Implications for Policy

City planners need to plan for a future with (potentially much) greater flood risk. This includes more frequent and intense flooding of places that are currently considered at risk, and flooding in places that are not currently considered at risk. While pursuit of compact urban development as a form of "sustainable" development is a worthy goal with many advantages, in some instances – such as in the case of Cork city – this could potentially come at the cost of further development in areas at risk from flooding. Ensuring that future urban development does not result in excessive increases in exposure to flooding will require that the (local) planning system takes account of flood risk and explicitly manages these difficult trade-offs in line with national policy guidelines. However, as the analysis presented here demonstrates, new development continues to be allowed in areas at risk from flooding around Ireland, particularly in areas where housing pressures are pronounced. This may be justifiable in some instances, and risks can be mitigated to some extent with property-level measures. Sustainable and climate resilient urban development will require, at a minimum, a more explicit discussion of (i) the long-term consequences of decisions taken today and (ii) the possible trade-offs between different policy goals in urban planning under climate change.

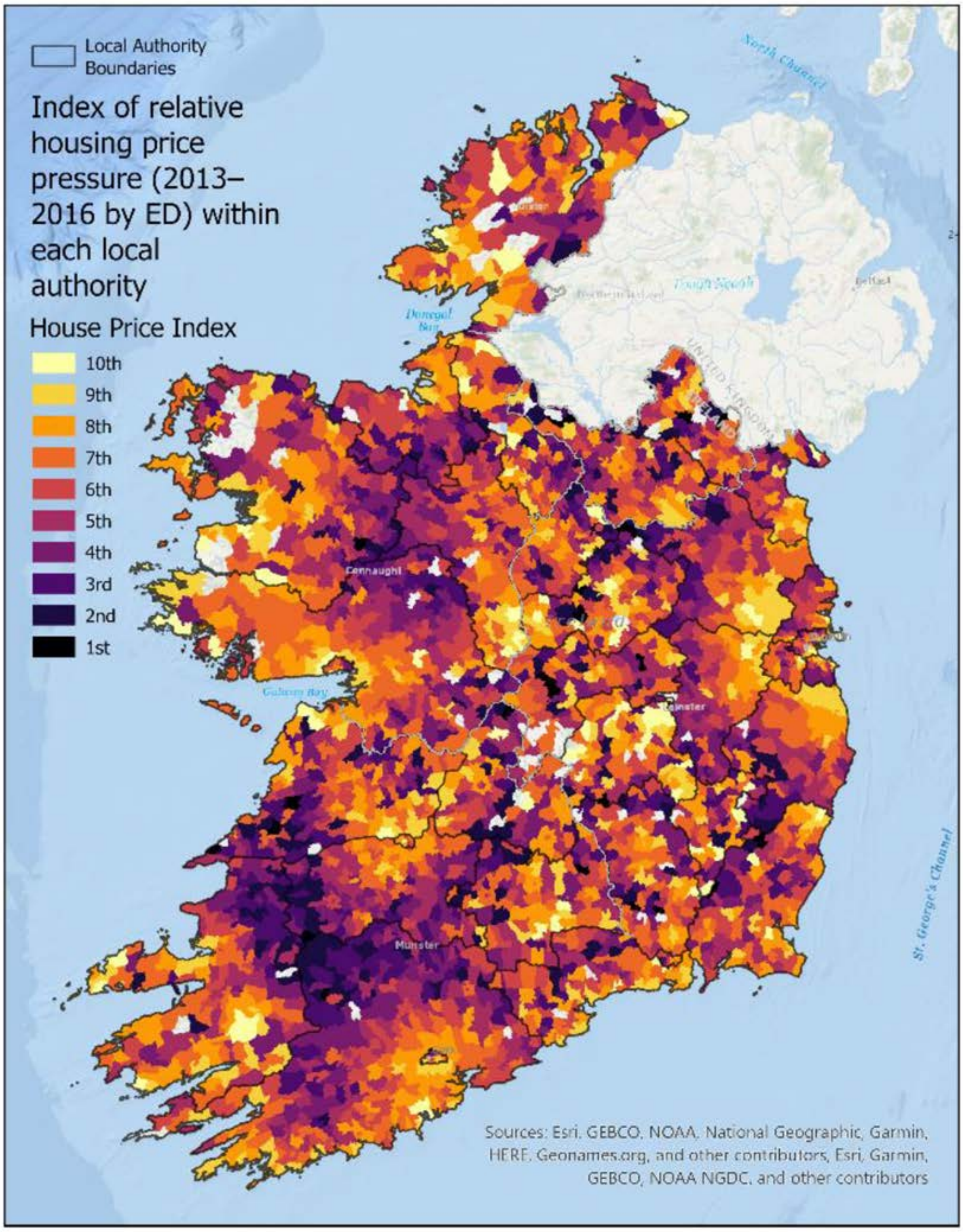

Figure 3.3. Index of relative housing price pressure (2013–2016) within each local authority. Brighter colours represent higher price pressure index values – standardised and reported in deciles.
ED, electoral division. This map was created using ArcGIS software by Esri. ArcGIS and ArcMap are the intellectual property of Esri and are used herein under licence. Copyright © Esri. All rights reserved.

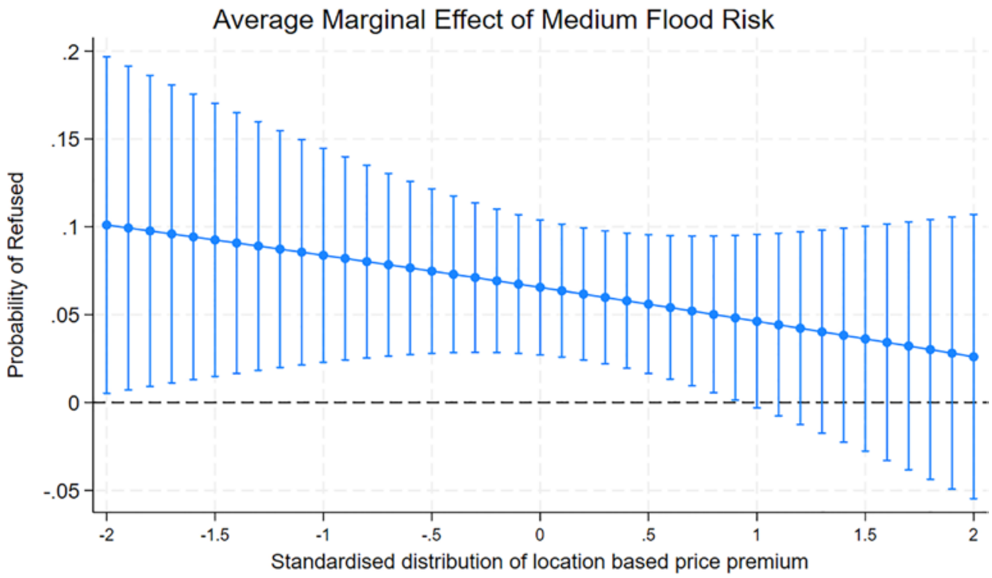

Figure 3.4. Estimated marginal effect (and 95% confidence intervals) of being in a medium-risk flood area on the probability of planning permission being refused for a standardised range of price pressure index values.

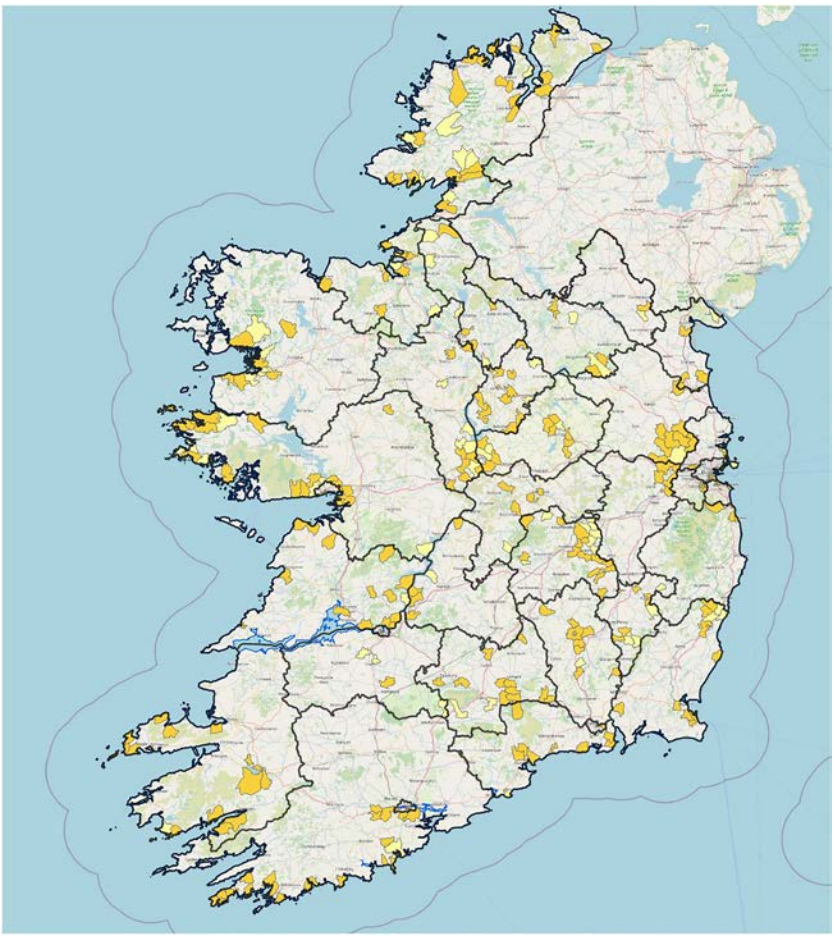

Figure 3.5. Map highlighting areas of the country where the analysis indicates that flood risk has no statistically significant effect on the probability of a planning application being rejected, based on local relative price pressure index values. This map was created using ArcGIS software by Esri. ArcGIS and ArcMap are the intellectual property of Esri and are used herein under licence. Copyright © Esri. All rights reserved.

4 Risk Perceptions

How do people perceive the risks from extreme weather events such as floods, and the potential increase in these risks due to climate change? To what extent are these risks factored into individual behaviours and decisions? This project took a number of complementary approaches to researching these questions. First, we examined to what extent flood risk affects property prices in Ireland. Second, we surveyed the public in Ireland about their views on flood risk and climate change. Finally, we talked to people living in a small coastal community, through semi-structured interviews, to understand their relationship with their local environment and the weather, their perceptions of climate change and related risks, and their views on the idea of a resilient community.

4.1 Flood Risk and Property Prices

4.1.1 Background and summary of the study

The willingness of individuals to purchase properties exposed to flood risk, and the sale price discount expected for such properties, are important topics for research, with implications for our understanding of both housing markets and flood risk perceptions. Analysis of these topics is of interest for two primary reasons. First, such analysis can provide insights into public perceptions of flood risk, which, in turn, reveal the welfare costs associated with flooding. Second, as highlighted in the previous chapter, housing markets play a central role in shaping exposure to flood risk and influencing the future costs associated with it. A price discount for properties at risk from flooding conveys information about the risk, while the absence of a price discount for such properties would suggest that the risk is not being considered by actors in the property market, potentially resulting in overexposure to risk.

Research as part of this project estimated a sale price discount for properties at risk from flooding in Ireland of 4%. In other words, these properties sell for, on average, 4% less than otherwise similar properties that are not at risk. Notably, this discount was not observed prior to the 2011 release of official flood risk maps for the first time in Ireland. This finding suggests that the availability of risk information is an important precondition for individuals to take flood risk into account in their decisions, even in high-stakes settings such as in the case of property transactions.

4.1.2 Methods and data

In this study, information from the housing market was combined with official flood risk maps, to estimate the difference in sale prices – if any – between properties at risk and those not at risk from flooding in Ireland. The housing market data used draw on two main sources: the Daft.ie listings archive (2006–2015) and the national Residential Property Price Register transactions database, which includes price and structural characteristics of close to half a million individual properties around the country. Individual-property-level information was combined with official flood risk maps sourced from the OPW to identify properties inside and outside assessed flood risk zones. The maps show areas with at least a 1% risk per year for fluvial flooding and at least a 0.5% risk per year for coastal flooding.

The estimation methods used – known as difference-in-difference estimation in economics jargon – essentially compare changes in prices of properties deemed at risk based on their location, with respect to the official risk maps (before and after the public release of the maps), against changes in prices of properties not at risk over the same period. This method takes account of other changes in the property market and wider economy that would have affected prices for all properties over the same period.

The inclusion of a large range of information on each individual property's characteristics and its location with respect to various amenities means that the analysis is on an apples-for-apples basis, comparing properties with similar physical characteristics in similar types of locations. The comparison is also further restricted to properties listed (or sold) in the same electoral division and the same year-quarter. These restrictions help to minimise the possibility of mistakenly attributing to flood risk the effects of some other factors that happened to influence house prices at the time that a (risky) property was sold, or the effects of some location characteristics relevant to sale prices – such as a nice sea view – that happen to overlap with flood risk areas.

4.1.3 Results

The results of the analysis show that properties at risk from flooding in Ireland sell with an average discount of 4% relative to similar properties located outside flood risk areas (see panel (a) of Figure 4.1). This estimate is robust to a range of checks, including varying the set of included controls and varying the way that the location and timing of property sales are accounted for.

The analysis also reveals that the discount for at-risk dwellings was not present prior to the release of the risk maps in 2011 and that it emerges quickly after the information release and persists for the remainder of the sample period (see Figure 4.2).

The estimated discount is also consistent even when restricting the comparison to properties located within small distance bands (less than 1 km, 500 m, 250 m, 100 m) on either side of the boundary of a flood risk area (see panel (b) of Figure 4.1). However, the analysis also shows that there is some "spillover" of the flood discount into neighbouring areas just outside flood risk zones (see panels (c) and (d) of Figure 4.1). In other words, it appears that participants in the housing market respond to official information about flood risk and take it into account in decision-making, but also consider areas adjacent to flood risk zones to be risky, albeit to a lesser extent, as the size of the estimated discount is substantially lower in these areas. For example, for properties within 100 m of a flood risk boundary but located outside the flood risk zone, the estimated price discount is 2.1% (see panel (d) of Figure 4.1).

4.1.4 Conclusions

The estimated flood risk discount of 4% for Irish property prices is roughly in line with international estimates. For example, two recent meta-analyses of studies from around the world estimated an average flood risk discount of 4.6% (Beltrán et al., 2018)

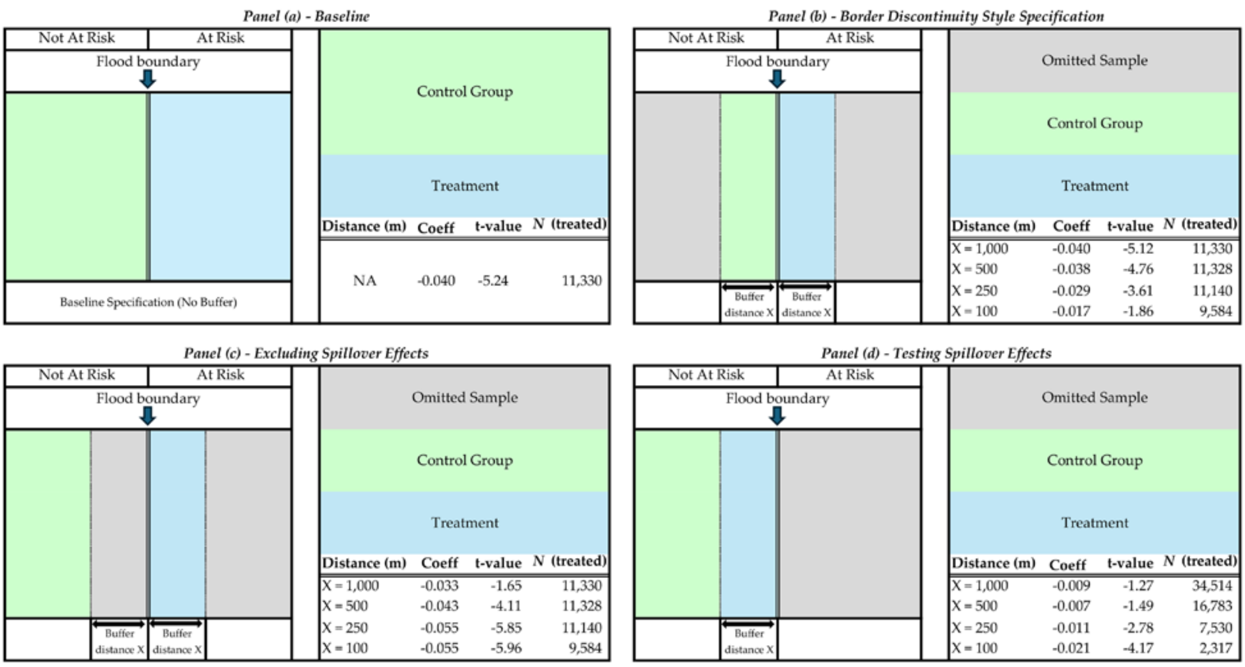

Figure 4.1. Estimates of the flood risk discount, for various comparison groups. Panel (a) compares all properties at risk with all properties not at risk. Panel (b) compares properties located within a given buffer distance on either side of a flood risk boundary. Panel (c) excludes properties just outside flood risk zones but within the buffer. Panel (d) compares those just outside flood risk zones but within the buffer with properties more than the buffer distance outside a flood risk zone. These comparisons are made for buffer thresholds of 1 km, 500 m, 250 m and 100 m. Coeff, coefficient.

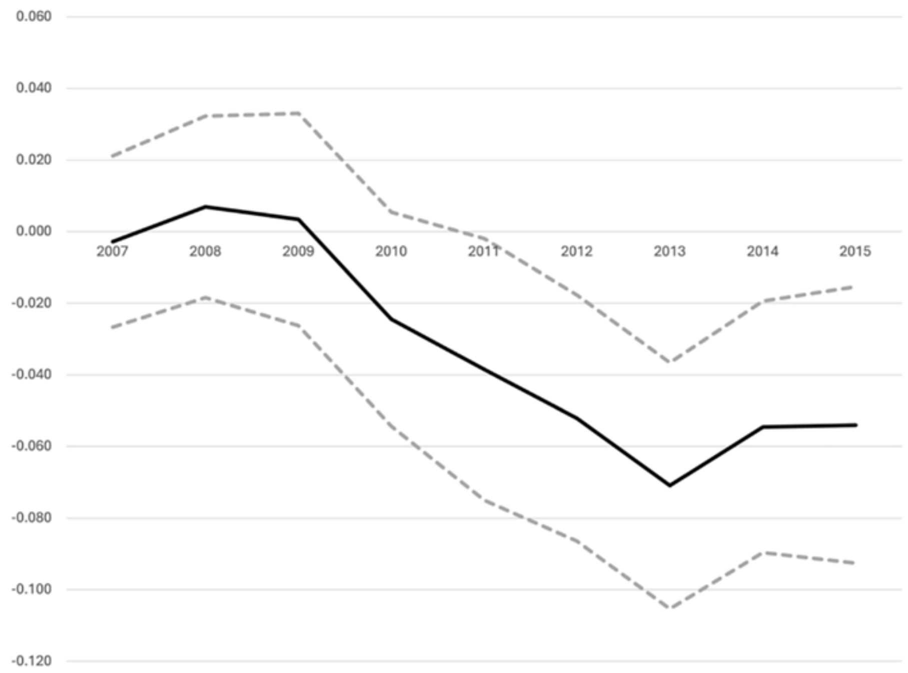

Figure 4.2. Estimates of the flood risk discount (and 95% confidence intervals) on the advertised sale price of properties in Ireland, 2007–2015.

and 5.2% (Contat et al., 2024). The estimated flood discount represents the causal effect of flood risk on housing prices, conditional on the availability of flood risk information. In the context of this study, it is perhaps best thought of as an estimate of the welfare costs of living with flood risk – including potential damage to property and the more hidden costs of flooding, such as disruptions to daily life and mental health costs – for households that choose to move to such areas.

The magnitude of the estimate, a 4% sale price discount, would be consistent with damage costs per flood event of between €24,000 and €60,000 as reasonable parameter values. For example, for a €300,000 dwelling (close to the average list price in the data used in this study) with a 1% annual flood risk, a 30-year horizon (roughly the length of a typical mortgage) and a 2% time discount rate, the estimated 4% discount on the price of the dwelling equates to expected damage costs per flood of €50,000 for an individual property. Calculated in perpetuity, the same discount implies damage costs of about €24,000 per event per property.

It is of course possible that the price discount for flood risk in the housing market does not capture the full welfare effects of flooding. For example, households (or market participants) may be at least partially shielded from the consequences of flooding by government compensation schemes or public investments in flood protection. Our estimates also exclude other non-residential costs of flooding such as damage to public infrastructure and commercial real estate. On this basis, the true costs of flooding to society are likely to be larger than what we estimate here.

These findings have important policy implications across several domains, including for flood risk management, insurance and flood defences, and projections of future flood losses in a world of increasing flood risk. Perhaps most importantly for policymakers, our results present compelling evidence on the effectiveness of public investments in flood risk information provision. Better information appears to result in more awareness and a clear price signal, which should translate over time into less exposure to flooding.

4.2 Survey of Public Attitudes to Flood Risk and Climate Change

A complementary survey of public attitudes towards flood risk in Ireland found widespread concern about the issue among the over 800 respondents. For many respondents, such concern has intensified over the past decade, and the majority expect flooding to worsen in the coming years. The survey also explored public opinions on appropriate price discounts for properties at risk from flooding, yielding an average suggested discount of approximately 31% – an order of magnitude greater than the observed discount derived from housing price data.

4.2.1 Self-reported attitudes to flood risk and flood defences

When asked to rank various amenities and disamenities in terms of their importance when choosing where to live, 54% of respondents ranked “no risk of flooding” as “very important”. This was the joint highest (in terms of frequency of respondents choosing “very important”), along with neighbourhood quality, and ahead of proximity to amenities including transport networks, the central business district, green spaces and schools.

A large share of respondents (45%) also said that flood risk had become more of a concern for them in the last 10 years, compared with just 4% who said it had become less of a concern for them (Figure 4.3). Looking to the future, 81% of respondents expect flood risk in Ireland to increase by the year 2050. In terms of direct experience of flooding, 12% of respondents said they had directly experienced flooding of a dwelling they were living in at some point in the past.

Concern about flood risk was notably different among those looking to buy compared with those looking to rent. Of those looking to buy a home, 58% rated avoiding flood risk as very important, while just 5% said it was not important (n = 298). In contrast, of those looking to rent, similar fractions rated avoiding flood risk as very important (32%) and not important (25%). Potential buyers were almost twice as likely as potential renters to state that flood risk was relevant to their search, and about half as likely to say that they did not know if flood risk was relevant.

The survey also probed the sources of flood risk salience. Respondents who indicated that their concern about flood risk had increased in the last 10 years were asked about the reasons for their increasing concern: 38% cited coverage of flooding in the media, 27% cited increased awareness of climate change and 12% chose “release of new information on flood risk”.

The survey also asked respondents about their attitudes towards flood defences. The majority of respondents (59%) agreed (or strongly agreed) with the statement “man-made flood defences provide an adequate protection against flood risk”. Half disagreed (or strongly disagreed) with the statement “man-made flood defences reduce your enjoyment of an area, either visually or otherwise”. And finally, a large majority (70%) agreed (or strongly agreed) with the statement “flood defences should be funded by general taxation”.

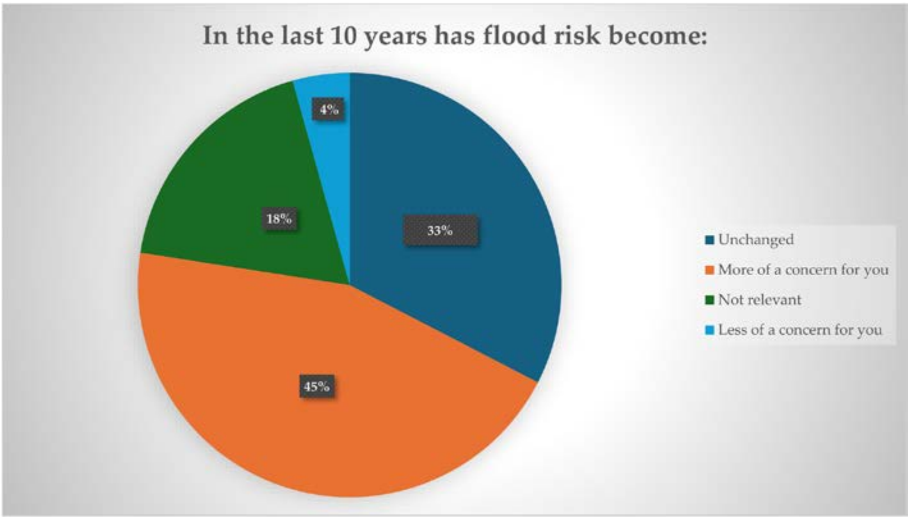

Figure 4.3. Share of respondents reporting changes in their level of concern about flood risk in the last 10 years.

4.2.2 Awareness of flood risk information

Despite concern about flood risk, the responses to the survey also indicate a continuing information deficit among housing market participants (Figure 4.4). Of those who said that flood risk was relevant for their search, over a third (37%) said they were not aware of the risk for their search area. Fewer than one in five respondents (17%) said they knew where to find flood risk information, while the majority (61%) said they did not know, and 22% said they thought it would be difficult to find. When asked about official flood risk maps, only 22% said they were aware of the existence of these maps.

These findings have important implications for policy as well as for the results presented above. The results of this survey imply that the availability of scientifically assessed risk information on its own is insufficient to ensure a well-informed public, even when the stakes are relatively high and when respondents report high levels of concern. Greater efforts to disseminate information and communicate it to the public may be required (see McDermott and Surminski, 2018, for a

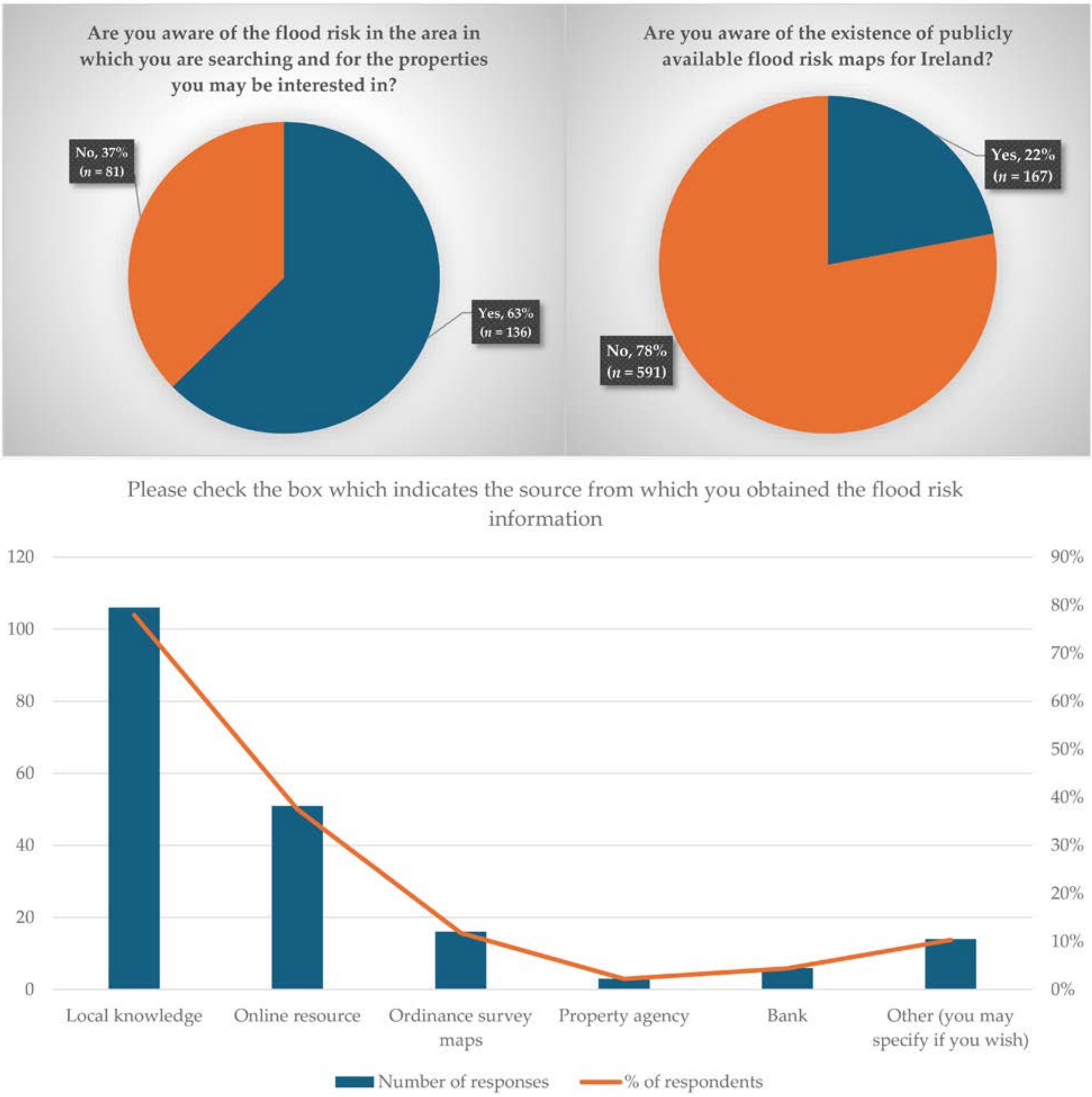

Figure 4.4. Share of respondents by awareness of flood risk in their search area (left panel) and awareness of official flood risk maps (right panel). Share of source of flood risk information for respondents who were aware of the flood risk in their locality (bottom graph).

related discussion on translating scientific assessment of flood risk for local decision-making).

4.2.3 Willingness to pay to avoid flood risk

A willingness-to-pay question was included in the survey, relating to people's perception of flood risk discounts on housing prices. Respondents were asked to imagine two identical houses that differ only in that one is at risk from flooding and the other is not. With the non-risky house priced at €300,000, respondents were asked what price they thought the house in the flood risk zone should be. Each respondent was randomly assigned different versions of the question with varying levels of flood risk for the risky property. The evidence from this question represents people's "stated preference" with respect to flood risk, where the evidence from the housing market analysis presented previously represents people's "revealed preferences" through outcomes in the housing market.

The mean flood discount across all responses was 31.4% (with a standard deviation of 21%). This large reduction – relative to estimates based on housing market data – suggests that respondents were not thinking about the decision in the same way that market participants act when facing this situation. How the participants made these decisions is not explained by impulsivity, buyer status or estimates of future flood risk, based on evidence from additional survey questions. The mean discount shows little variation across the three different levels of risk specified in different versions of the question: increasing the flood risk 100-fold affects the stated discount, but only by an average of €14,000. This may indicate an issue with the interpretation or assessment of flood risk probabilities. Willingness to pay to avoid flood risk does appear to be influenced by the self-reported *importance* and *relevance* of flood risk. While responses on the importance and relevance of flood risk overlap, they do not overlap as much as expected.

These stated-preference results suggest a much larger flood discount – indeed, an order of magnitude larger – than the discount that emerged from the housing price analysis. This substantial gap between the observed and self-reported flood discounts may be attributed to several factors. It is possible that the larger, survey-based discount reflects methodological influences, such as the heightened salience of flood risk prompted by the survey question or "cheap talk" criticisms associated with responses to hypothetical scenarios. However, it is also plausible that the welfare costs of flooding are not fully captured in housing market prices. Evidence from the survey suggests that individuals may implicitly assign higher probabilities to flood risks than those indicated by scientific assessments, particularly in areas classified as having a low (but non-zero) risk of flooding.

This tendency to overweight flood risk, particularly in low-risk areas, may stem from deficiencies in the communication of risk information to the public – a phenomenon well documented in behavioural economics, where excessive weight is often assigned to low-probability outcomes. Alternatively, it may reflect a deliberate scepticism about scientific risk assessments, whereby a majority of respondents consider those assessments to understate the true risk.

Understanding how individuals interpret and act upon flood risk information remains a critical area for future research. Insights from studies on this topic are essential for informing policy in key areas, including flood risk management, insurance design and the implementation of flood defence measures. Furthermore, a deeper understanding of these dynamics will support more accurate projections of future flood losses in a world increasingly affected by rising flood risks.

4.3 Community Interviews in Loop Head, County Clare

4.3.1 Background

The project also involved complementary qualitative research on risk perceptions in relation to floods, extreme weather events and climate change, through a series of semi-structured interviews with people living in a small coastal community in the west of Ireland (Loop Head, County Clare). This work was undertaken in collaboration with Raidió Corca Baiscinn (RCB), south-west Clare's non-profit community radio station, with inputs from John Aston and Carsten Krieger at AstonECO and members of the Loop Head Together community group.

The aim of the interviews was to develop insights on people's relationship with their local environment and the weather, their perceptions of climate change and related risks, and their views on the idea of a resilient community.

This part of the project culminated in the production of a short podcast series, *Loop Head Climate Change*, which first aired on RCB in July 2024 and is available to stream directly from our project web page: https://stories.universityofgalway.ie/climate-resilient-places/index.html.

4.3.2 Findings from community interviews

In this section, a few highlights and insights from the community interviews, as noted by the research team, are summarised briefly.

One clear finding was that people are in general very aware of the natural environment around them and have observed changes in that environment over time. Some mentioned changes in the prevalence of certain species, which may not be related to climate change. However, many also referred to changing weather patterns, for example milder winters and wetter summers, which correspond with the latest scientific observations and the predictions of climate models. In terms of the prevalence of “extreme” weather events, such as storms and floods, the general impression among interviewees was that these phenomena have always occurred – particularly in a place that is exposed to Atlantic weather systems and frequent “wild” or stormy weather, as Loop Head is. In scientific jargon, it seems that a climate signal in the prevalence of extreme weather events is not readily observable for the average person.

People’s affinity for and connection with the weather was also evidenced in the stories interviewees recounted of local folklore and ways of predicting the weather from natural indicators. It was clear that many interviewees took a certain pride in being able to survive and thrive in a place that regularly experiences “wild” Atlantic weather. When asked to reflect on resilience, many of those interviewed expressed that they already felt they were resilient and that a person needed to be resilient to live in a rural coastal community in the west of Ireland. The nature of the community as a source of resilience was also commented upon in this context, in terms of the community’s sense of togetherness and cooperation in the face of adversity, reflecting the importance people place on local social capital.

Alongside the many positive and optimistic sentiments that were expressed, people also talked about the damage and destruction that had been experienced as a result of past storms and floods. Some also expressed concern about the potential increases in extreme weather that could result from the effects of climate change. However, negative sentiments were also expressed in relation to weather warnings and forecasts. While the dilemmas faced by forecasters were acknowledged, in terms of not wanting to miss a potentially damaging event (i.e. the need to avoid false negatives), there were also some references to warnings that did not materialise, and even a sense that the naming of storms and the issuing of colour-coded alerts was a form of hype or sensationalism. These views reflect the danger of “false positives”, whereby people quickly become disillusioned with warnings and forecasts that turn out not to reflect their experiences at the local level.

In terms of investments and adaptation required at the local level, perhaps the most prominent voice in this research was an engineer experienced in working with local authorities, who was interviewed as part of the podcast series. They noted that significant local investments in infrastructure would be required to cope with the effects of a changing climate, while some difficult decisions would ultimately need to be made at the local level about where defensive efforts and coastal protection can be sustained over the long term, and what lands or roads might eventually become too difficult or costly to protect and maintain as the hazards from coastal flooding increase over time.

4.3.3 Conclusion

Other parts of this project have demonstrated the need for adaptation to the effects of a changing climate, for example because of the potential increase in the risks from flooding. At the same time, housing pressures mean that new development continues to add further exposure to flood risk. Without concerted action in terms of investment, adaptation and ultimately resilience at the local level, the costs and disruptions associated with extreme weather events will continue to escalate.

Creating climate resilient places will require local efforts and investments. However, effecting change also requires bringing people on board, connecting the science with people’s everyday lived experiences and starting conversations about the choices and trade-offs that will need to be made. This also means acknowledging that climate change and associated risks are not always at the forefront of people's day-to-day thinking and that people and communities have other goals, objectives, aims and aspirations that may or may not align with an agenda that is focused solely on adapting to risks.

The concept of resilience has the potential here to act as a rallying call and as a focal point for a more positive or optimistic conversation about building climate resilient places and communities. The findings from our community engagement suggest that the process of fostering these kinds of conversations at the local level remains in its infancy in Ireland. A concerted effort will be required over the coming years to engage communities in developing a shared understanding of, for example, (i) the threats and risks from a changing climate; (ii) the potential opportunities at the community level from pursuing a resilience model; (iii) what it means to be resilient; and (iv) what a climate resilient version of their community will look like in 2050.

5 Recommendations

The analysis presented in this project lays bare the consequences of unabated climate change at the very local level in Ireland. Quantifying the social and economic consequences of a changing climate at any scale is challenging. Translating these impacts into monetary costs is useful to provide context for evidence-based policymaking, and to enable cost–benefit calculations for public investments in climate change mitigation and adaptation. Existing estimates of costs related to climate change impacts tend to be at the global, or in some cases national, level. In contrast, this research presents hyperlocal estimates of the costs of climate change. Local costs and damage costs under climate change provide the motivation to act to reduce emissions. While global estimates are a prerequisite for (global) mitigation policies, they can feel disconnected from people's everyday lived experiences, as evidenced by the community engagement part of this research project.

The analysis demonstrates that, without (global) mitigation of greenhouse gas emissions, local flood risk and associated damage costs will rise to unacceptable levels. Estimates of these localised costs are also needed to guide planning decisions, investment and adaptation efforts. Policymakers need to think about how their plans are likely to perform under different future climate scenarios – particularly with an emphasis on the "worst case scenario" type of modelling presented here. In general, city planners need to start planning now for a future with (potentially much) greater flood risk. Ensuring that future urban development does not result in excessive increases in exposure to flooding will require that the (local) planning system takes account of flood risk both now and into the future. Adaptation is costly and challenging, and those costs and challenges increase dramatically with the extent of warming. In other words, there is a strong interplay or interdependence between (global) mitigation and (local) adaptation; local adaptation strategies depend strongly on the extent and success of (global) mitigation policies.

In terms of the burden of these growing costs, it seems unlikely that dramatically increased risk at the local level would be underwritten over the longer term by private insurance markets. The costs of this increased risk will ultimately fall either on local communities (residents; property and business owners) or on (local and national) government, and in turn on taxpayers. Policymakers will be faced with increasingly stark choices, for example funding very large-scale defensive investments to continue to protect at-risk communities or paying enormous bills for recovery assistance in the aftermath of each new flood event. Innovative schemes that aim to mitigate damage at the individual property level, while larger defensive investments are made, can be helpful in bridging such gaps.[5] But, ultimately, the intensification of risk will result in higher costs to the public purse.

Increased risk and costs associated with a warming planet also raise important distributional issues. It is well established that lower-income households have less coping capacity for protecting themselves in advance, and dealing with the consequences, of extreme weather events. Increased risk and costs are therefore likely to place a heavier burden on lower-income households. Similarly, if (future) flood risk is priced into housing markets, some households may be priced out of safer areas, resulting in an income gradient in exposure to risk. This contrast might again become more pronounced as that risk increases to the point where private insurance becomes increasingly unavailable in the riskiest areas. These distributional consequences of a changing climate, and how they might be mediated via housing markets, remain important areas for future research.

The evidence presented in this report is useful for informing policymaking across a range of domains, for example (i) informing local investment and planning decisions; (ii) understanding the distributional consequences of a changing climate at the local level (informing environmental justice concerns); (iii) motivating action, given that more aggregated

5 See, for example, https://www.corkcoco.ie/en/resident/water-services-coastal-and-flood-projects/midleton-and-east-cork-individual-property-protection-ipp-scheme (accessed 29 January 2026).

estimates of losses or impacts can be too abstract to influence decision-making at the individual or community level; and (iv) assessing the potential socio-economic costs of climate change in Ireland.

That said, further research and follow-up work is also needed on multiple fronts, for example to explore the local impacts and costs for other, intermediate, climate scenarios and to replicate this type of analysis for other locations around Ireland.

This project has argued that the concept of resilience can act as a focal point for a more positive or optimistic conversation about building climate resilient places and communities. The findings from our community engagement suggest that the process of fostering these kinds of conversations at the local level remains in its infancy in Ireland. A concerted effort will be required over the coming years to engage communities in developing a shared understanding of, for example:

- the threats and risks from a changing climate;
- the potential opportunities at the community level from pursuing a resilience model;
- what it means to be resilient;
- what a climate resilient version of their community will look like in 2050.

The Climate Resilient Places research project aims to take the first steps in developing the evidence and starting the conversations that will underpin the creation of climate resilient places in Ireland.

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Abbreviations

AAL	Average annual loss
CoDEC	Coastal Dataset for the Evaluation of Climate Impact
MSL	Mean sea level
NPAD	National Planning Application Database
OPW	Office of Public Works
RCB	Raidió Corca Baiscinn
RP	Return period
SSP	Shared Socioeconomic Pathway

An Ghníomhaireacht Um Chaomhnú Comhshaoil

Tá an GCC freagrach as an gcomhshaol a chosaint agus a fheabhsú, mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ar thionchar díobhálach na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialáil: Rialáil agus córais chomhlíonta comhshaoil éifeachtacha a chur i bhfeidhm, chun dea-thorthaí comhshaoil a bhaint amach agus díriú orthu siúd nach mbíonn ag cloí leo.

Eolas: Sonraí, eolas agus measúnú ardchaighdeáin, spriocdhírithe agus tráthúil a chur ar fáil i leith an chomhshaoil chun bonn eolais a chur faoin gcinnteoireacht.

Abhcóideacht: Ag obair le daoine eile ar son timpeallachta glaine, táirgiúla agus dea-chosanta agus ar son cleachtas inbhuanaithe i dtaobh an chomhshaoil.

I measc ár gcuid freagrachtaí tá:

Ceadúnú

> Gníomhaíochtaí tionscail, dramhaíola agus stórála peitril ar scála mór;
> Sceitheadh fuíolluisce uirbigh;
> Úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe;
> Foinsí radaíochta ianúcháin;
> Astaíochtaí gás ceaptha teasa ó thionscal agus ón eitlíocht trí Scéim an AE um Thrádáil Astaíochtaí.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil

> Iniúchadh agus cigireacht ar shaoráidí a bhfuil ceadúnas acu ón GCC;
> Cur i bhfeidhm an dea-chleachtais a stiúradh i ngníomhaíochtaí agus i saoráidí rialáilte;
> Maoirseacht a dhéanamh ar fhreagrachtaí an údaráis áitiúil as cosaint an chomhshaoil;
> Caighdeán an uisce óil phoiblí a rialáil agus údaruithe um sceitheadh fuíolluisce uirbigh a fhorfheidhmiú
> Caighdeán an uisce óil phoiblí agus phríobháidigh a mheasúnú agus tuairisciú air;
> Comhordú a dhéanamh ar líonra d'eagraíochtaí seirbhíse poiblí chun tacú le gníomhú i gcoinne coireachta comhshaoil;
> An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Dramhaíola agus Ceimiceáin sa Chomhshaol

> Rialacháin dramhaíola a chur i bhfeidhm agus a fhorfheidhmiú lena n-áirítear saincheisteanna forfheidhmithe náisiúnta;
> Staitisticí dramhaíola náisiúnta a ullmhú agus a fhoilsiú chomh maith leis an bPlean Náisiúnta um Bainistíocht Dramhaíola Guaisí;
> An Clár Náisiúnta um Chosc Dramhaíola a fhorbairt agus a chur i bhfeidhm;
> Reachtaíocht ar rialú ceimiceán sa timpeallacht a chur i bhfeidhm agus tuairisciú ar an reachtaíocht sin.

Bainistíocht Uisce

> Plé le struchtúir náisiúnta agus réigiúnacha rialachais agus oibriúcháin chun an Chreat-treoir Uisce a chur i bhfeidhm;
> Monatóireacht, measúnú agus tuairisciú a dhéanamh ar chaighdeán aibhneacha, lochanna, uiscí idirchreasa agus cósta, uiscí snámha agus screamhuisce chomh maith le tomhas ar leibhéil uisce agus sreabhadh abhann.

Eolaíocht Aeráide & Athrú Aeráide

> Fardail agus réamh-mheastacháin a fhoilsiú um astaíochtaí gás ceaptha teasa na hÉireann;
> Rúnaíocht a chur ar fáil don Chomhairle Chomhairleach ar Athrú Aeráide agus tacaíocht a thabhairt don Idirphlé Náisiúnta ar Ghníomhú ar son na hAeráide;
> Tacú le gníomhaíochtaí forbartha Náisiúnta, AE agus NA um Eolaíocht agus Beartas Aeráide.

Monatóireacht & Measúnú ar an gComhshaol

> Córais náisiúnta um monatóireacht an chomhshaoil a cheapadh agus a chur i bhfeidhm: teicneolaíocht, bainistíocht sonraí, anailís agus réamhaisnéisiú;
> Tuairiscí ar Staid Thimpeallacht na hÉireann agus ar Tháscairí a chur ar fáil;
> Monatóireacht a dhéanamh ar chaighdeán an aeir agus Treoir an AE i leith Aeir Ghlain don Eoraip a chur i bhfeidhm chomh maith leis an gCoinbhinsiún ar Aerthruailliú Fadraoin Trasteorann, agus an Treoir i leith na Teorann Náisiúnta Astaíochtaí;
> Maoirseacht a dhéanamh ar chur i bhfeidhm na Treorach i leith Torainn Timpeallachta;
> Measúnú a dhéanamh ar thionchar pleananna agus clár beartaithe ar chomhshaol na hÉireann.

Taighde agus Forbairt Comhshaoil

> Comhordú a dhéanamh ar ghníomhaíochtaí taighde comhshaoil agus iad a mhaoiniú chun brú a aithint, bonn eolais a chur faoin mbeartas agus réitigh a chur ar fáil;
> Comhoibriú le gníomhaíocht náisiúnta agus AE um thaighde comhshaoil.

Cosaint Raideolaíoch

> Monatóireacht a dhéanamh ar leibhéil radaíochta agus nochtadh an phobail do radaíocht ianúcháin agus do réimsí leictreamaighnéadacha a mheas;
> Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha;
> Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta;
> Sainseirbhísí um chosaint ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Ardú Feasachta agus Faisnéis Inrochtana

> Tuairisciú, comhairle agus treoir neamhspleách, fianaise-bhunaithe a chur ar fáil don Rialtas, don tionscal agus don phobal ar ábhair maidir le cosaint comhshaoil agus raideolaíoch;
> An nasc idir sláinte agus folláine, an geilleagar agus timpeallacht ghlan a chur chun cinn;
> Feasacht comhshaoil a chur chun cinn lena n-áirítear tacú le hiompraíocht um éifeachtúlacht acmhainní agus aistriú aeráide;
> Tástáil radóin a chur chun cinn i dtithe agus in ionaid oibre agus feabhsúchán a mholadh áit is gá.

Comhpháirtíocht agus Líonrú

> Oibriú le gníomhaireachtaí idirnáisiúnta agus náisiúnta, údaráis réigiúnacha agus áitiúla, eagraíochtaí neamhrialtais, comhlachtaí ionadaíocha agus ranna rialtais chun cosaint chomhshaoil agus raideolaíoch a chur ar fáil, chomh maith le taighde, comhordú agus cinnteoireacht bunaithe ar an eolaíocht.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil

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

1. An Oifig um Inbhunaitheacht i leith Cúrsaí Comhshaoil
2. An Oifig Forfheidhmithe i leith Cúrsaí Comhshaoil
3. An Oifig um Fhianaise agus Measúnú
4. An Oifig um Chosaint ar Radaíocht agus Monatóireacht Comhshaoil
5. An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tugann coistí comhairleacha cabhair don Ghníomhaireacht agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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