Banc Ceannais na hÉireann
Central Bank of Ireland
Eurosystem

The Flood Protection Gap

October 2024

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Introduction

This report presents the results of our analysis of the Flood Protection Gap, both today and in the future, in the hopes of informing stakeholders in their efforts to address this important issue.

"The clock is ticking and the window of opportunity to take preventative action may be closing faster than we realise"

Gabriel Makhlouf, Governor of the Central Bank of Ireland

The Flood Protection Gap refers to the shortfall between the cost of flooding in Ireland and that portion of the cost which is insured. Lack of access to insurance can affect Irish communities and businesses in a very real way. The occurrence of a severe flood could leave households and business with high levels of uninsured losses, impairing economic recovery from a flood event, and create a need for government to provide financial support or compensation. In addition, there is potential for risk to be transmitted to other parts of the financial system, for example by impacting the availability of credit (mortgages and loans to small businesses in particular) in areas at risk of flooding. These issues, financial stability and the best interests of consumers, are core to the mission of the Central Bank.

In light of these significant issues, the Central Bank undertook research into the nature and scale of the Flood Protection Gap in Ireland, which considered both the picture today and how that picture might change in future, taking the effects of climate change into account[1].

The flood risk of each residential and commercial address in the State was analysed, down to Eircode level. Whether each address is likely to be able to access flood insurance, based on typical underwriting criteria in the Irish market, was then assessed. This report presents the results of this analysis, in the hopes of shedding further light on the nature of flood risk in Ireland and the scale of the protection gap today.

Much important work has already been completed on this topic. The insurance industry plays a very important role in protecting

[1] It is important to note that this is a 'point in time' analysis of the data available in H1 2024.

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consumers and businesses from the full impact of large, unpredictable events, such as floods, significantly mitigating the social and economic impacts when these occur. The Central Bank has already seen the benefit of co-operation between the public and private sectors in this area, including, for example, a Memorandum of Understanding (MoU) between Insurance Ireland and the Office of Public Works (OPW) which allows for sharing of information.

Ireland has broadly managed flood risk to date, but as with many other aspects of climate change, we cannot assume that current approaches will remain viable. It is intended that this analysis will be used to better inform a solutions-focused debate on this issue. As the Governor of the Central Bank commented recently in respect of flood risk: "*significant progress has already been made, but the clock is ticking and the window of opportunity to take preventative action may be closing faster than we realise*". Meaningful action in this space will require the involvement, and perspectives, of a broad spectrum of stakeholders.

What is a Flood Protection Gap?

A protection gap is typically defined as the shortfall between the economic losses arising from an event and insured losses from the same event[2]. Economic losses can arise from a variety of sources such as damage to physical assets, business disruption or lost income and clean-up costs borne by the State. The shortfall between economic and insured losses can be caused by lack of access to insurance or by a choice not to purchase insurance.

A protection gap is the shortfall between economic losses and insured losses

For this project, the Flood Protection Gap is considered in terms of the accessibility of insurance i.e. if a home or commercial property owner seeks to obtain flood cover on their property insurance today, will it be available? It should be noted that, this does not correspond to the actual number of properties without flood cover, which may be affected by other factors such as a decision not to purchase property insurance.

[2] See for example: https://www.eiopa.europa.eu/browse/sustainable-finance/addressing-protection-gaps_en?prefLang=sl

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Key Findings

Approximately 1 in 20 buildings has limited access to flood cover today. This means that if all buildings in Ireland sought flood cover today, approximately 1 in 20 will either be refused or will have fewer insurers willing to provide cover and will face increased scrutiny in the underwriting process, which could result in higher premiums or excesses.

1 in 20 buildings today has limited access to flood cover

The estimated average cost of inland flooding in Ireland annually is circa €101m annually. Of that cost, approximately 89% is associated with the higher flood risk buildings which have limited or no access to insurance. Severe losses can be much higher than this, with a €510m loss expected about once every 25 years. Coastal flooding is excluded from these estimates and could increase that number significantly.

Estimated average annual cost of inland flooding is €101m

Finally, concentration of risk is a significant feature of flood risk in Ireland. There are certain counties across the country where the protection gap is concentrated, with 54% of the protection gap concentrated in just five counties - Dublin, Cork, Kildare, Clare and Louth.

The protection gap is concentrated in five counties

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Flood Risk in Ireland

Flood risk is not a new risk in Ireland. There is a long history of work carried out by various stakeholders to manage and mitigate the risk presented by flooding in Ireland.

In recent history, this includes the planning guidelines issued by the OPW, the establishment of the Catchment Flood Risk Assessment and Management (CFRAM) Programme, the establishment of the MoU between the insurance industry and the OPW, the commitment of €1.3bn to flood risk management in the National Development Plan, and the establishment of the Flood Forecasting Centre by Met Éireann.

Types of flooding

There are three material types of flood risk in Ireland:

- Coastal flooding
- River (fluvial) flooding
- Surface water (pluvial) flooding

Any given flood results from a complex set of interacting processes, including:

- Meteorological conditions i.e. the length and intensity of the rainfall and any preceding rain's impact on the saturation of the ground;
- Terrain and geology, including local features such as hills and valleys; and
- Man-made structures such as houses and general infrastructure

Flood damage varies depending on the duration of event, the depth of the flood water and the type of water, for example salt water causes more damage than fresh water.

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Flood Defences

As an island, with an extensive river network where towns and cities have been built by the coasts and on the banks of rivers for historical trade reasons, efforts have been made to mitigate the risk of flooding as far as possible with flood defences.

Flood defences are structures, systems and strategies designed to reduce the risk and to mitigate the impact of flooding. Flood defences are designed and built to provide certain levels of protection, typically referred to as the Standard of Protection (SoP). The SoP is stated in terms of the return period of the flood it protects against. For example, a defence built to a 1 in 100-year standard of protection will protect the benefitting buildings for up to a 1 in 100-year flood event. Where the flood event is more severe than this standard of protection, the defence will be overtopped.

There are two main types of defences:

- Fixed defences, which are permanent structures
- Demountable defences, which require some level of human intervention in the event of a flood such as the closure of a gate

Photo 1 | Fixed defence in Sandymount, Dublin

Photo credit: independent.ie

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Photo 2 | Demountable defence in Athlone, Westmeath

Photo credit: Gamma Intelligence

Through extensive engagement with the insurance industry, the Central Bank ascertained that, in general, insurers consider fixed defences when assessing flood risk but do not consider demountable defences. This is due to the uncertainty and risks associated with the requirement for human intervention when deploying demountable defences.

Data Analysis Framework

In order to assess the flood protection gap, the following questions were considered:

- How many buildings in Ireland are vulnerable to flooding?
- Of those buildings, how many will face difficulties in accessing flood insurance?
- What is the expected cost of flooding to those properties, looking at both average and extreme losses?

Through our engagement with the insurance industry, it was established that flood scores developed by JBA Risk Management (JBA) are widely used in the underwriting of flood risk in Ireland. Therefore, using these flood scores to assess the protection gap provides a reliable view of the accessibility of flood insurance in

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Ireland. The Central Bank sourced this data from two providers in the Irish market, JBA and Gamma Intelligence (Gamma).

JBA flood scores were used to assess flood risk at a given Eircode, and take into account all three sources of flooding i.e. coastal, river and surface water. The scores represent a qualitative rating system developed by JBA, and are underpinned by a set of matrices that measure flood risk in terms of flood depth and probability of occurrence.

Flood scores were produced for every Eircode in Ireland

In order to understand how the flood scores are used by insurers, the Central Bank issued a flood underwriting questionnaire to nine insurers and hosted follow up meetings. This information was used to supplement the analysis work by establishing underwriting criteria reflective of typical market practice.

Flood costs were modelled for inland flooding only (river and surface water), excluding coastal flooding

All buildings in the Eircode Address Database (ECAD) were included. For example, an apartment block could include many apartments with many Eircodes, but these are counted as only one building.

Flood costs were modelled for inland flooding (river and surface water) only, as coastal costs are typically dealt with in other models which were not available from these providers. These costs are those associated with individual buildings only (that is, they do not include costs such as government clean-up costs, infrastructure repairs or business interruption costs).

The flood cost model calculates an estimated cost of flooding, and produces a distribution of costs across various return periods. It is a stochastic model[3] that runs ten thousand simulations of potential flood experience. Flood depths are modelled at each location and the rebuild cost for each building is cross-referenced, to calculate the cost of the flood damage. The model produced average annual losses for each building, which could be aggregated up by location or by flood risk rating.

Flood defences are also modelled within the cost model. There are two sources of information on defences; the OPW and JBA's own research. Information on OPW defences is provided via the

[3] A Stochastic Model is a mathematical method used in predicting statistical properties of outcomes by considering random variances in parameters over time, often based on historical data.

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Memorandum of Understanding[4] between the OPW and Insurance Ireland. Information on other defences is provided by JBA's own terrain mapping. Based on the Central Bank's engagements with insurers, information provided under the MoU on OPW demountable defences is not taken into account by the majority of the insurance industry. Some firms may do additional underwriting for individual policies, and take their own view of defences; such views are also not considered in the JBA flood scores.

Insurance companies typically take fixed flood defences into account in underwriting

[4] Insurance Ireland is the industry representative body for insurers in Ireland. Under the MoU, the OPW provides insurers with detailed information on flood defences built by the OPW. The MoU contains defined criteria that must be met for defences to considered, such as minimum standard of protection, certification of completion and maps of benefitting areas.

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The Protection Gap today

Flood Insurance Acceptance Criteria

Insurers use flood scores in different ways to assess flood risk; many insurers also layer in their own judgement, risk appetite and own history of flood claims.

The table below reflects typical underwriting practices based on the responses received from the flood underwriting questionnaire issued to nine of the main property insurers in the Irish market.

Table 1 | Summary of flood ratings, associated flood risk, and implications for insurance availability

Rating	JBA Flood Score	Flood Risk	Insurance Availability
Not at Risk	0	None	Available
Green	1-7	Low	Available
Amber	8-13	Medium	Limited
Red	14-30	High	Unavailable
Black	31-52	Very High	Unavailable

National Flood Protection Gap

There are approx. 2,020,315 buildings[5] in Ireland, of which 89% are residential (e.g. homes) and the remaining 11% are commercial (e.g. businesses, offices, and other commercial properties). Of that, approximately 290,855 have some level of exposure to flood risk.

Almost 68,732 buildings are protected by defences. This number includes around 5,000 buildings protected by fixed OPW defences, which are typically taken into account by the insurance industry. The remaining buildings are afforded some level of protection from other forms of defences, including OPW demountable defences, and those visible in JBA's terrain mapping, e.g. culverts.

[5] These figures are coming from the ECAD Eircode database used in this project.

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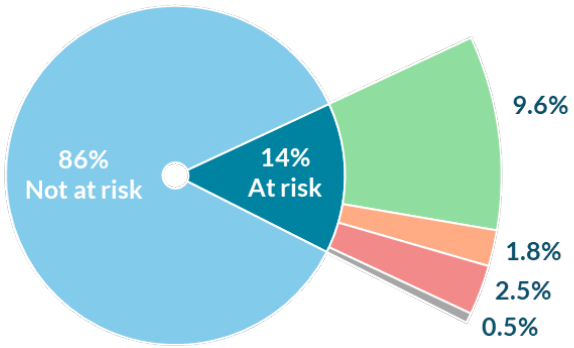
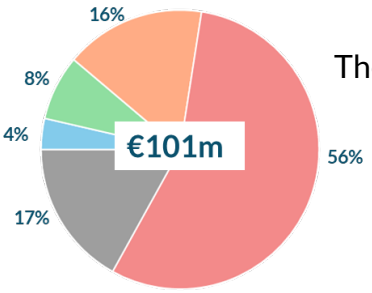
Chart 1 shows the national flood protection gap today, i.e. the number of buildings that have difficulty accessing insurance, and the modelled losses associated with those buildings.

Chart 1 | Number of buildings per flood risk category - baseline



14% of buildings (or 290,855) are at risk of flooding, and of those, 1 in 20 buildings (or 4.8% - those with an amber, red or black score) have limited access to flood cover.

Chart 2 | Average Annual Loss (AAL) per flood risk category - baseline



The

# Buildings	Total AAL	Per building
1,729,460	€ 3.6 m	€ 2
194,679	€ 7.6 m	€ 39
36,229	€ 16.5 m	€ 456
50,022	€ 56.2 m	€ 1,123
9,925	€ 17.1 m	€ 1,724

The average annual loss for inland flooding is modelled as €101m, with coastal flooding likely to add significantly to that cost

The AAL for inland flooding is modelled as €101m[6], with approximately €90m of this associated with buildings with limited flood cover. Chart 2 demonstrates that the cost of flooding increases significantly with increasing flood scores. These figures do not include losses arising from coastal flooding.

When coastal flooding is taken into account, these losses are likely to rise significantly given the extent of buildings located around the coastline of Ireland and the additional damage done by salt water.

[6] Note that this figure does not include costs for coastal flooding.

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SPOTLIGHT: What effect do Demountable Defences have?

Demountable flood defences require some intervention to operate them, for example closing a gate or building a temporary wall. Approximately 4,500 buildings nationally are protected by demountable defences, and the use of such defences is concentrated in certain towns.

The insurance industry typically excludes demountables from consideration when underwriting[7], due to concerns around the manual intervention required to deploy the defences, the risk of human error resulting in failure, and uncertainty around who is liable for losses in such a scenario.

In order to understand the impact that demountables make in managing flood risk, the example of Waterford City was examined. A demountable defence on the River Suir provides flood protection to 408 buildings in Waterford City. Results from the loss model with and without the demountables included were examined, to understand the impact of the demountable defence in managing flood risk. Including demountables reduced the modelled average loss for Waterford City by 77%, showing that demountables make a material difference to the cost of flood damage in the towns where they are used.

7 https://assets.gov.ie/46316/bcabf18615dd4bbbaa44c462e4c9d2b0.pdf

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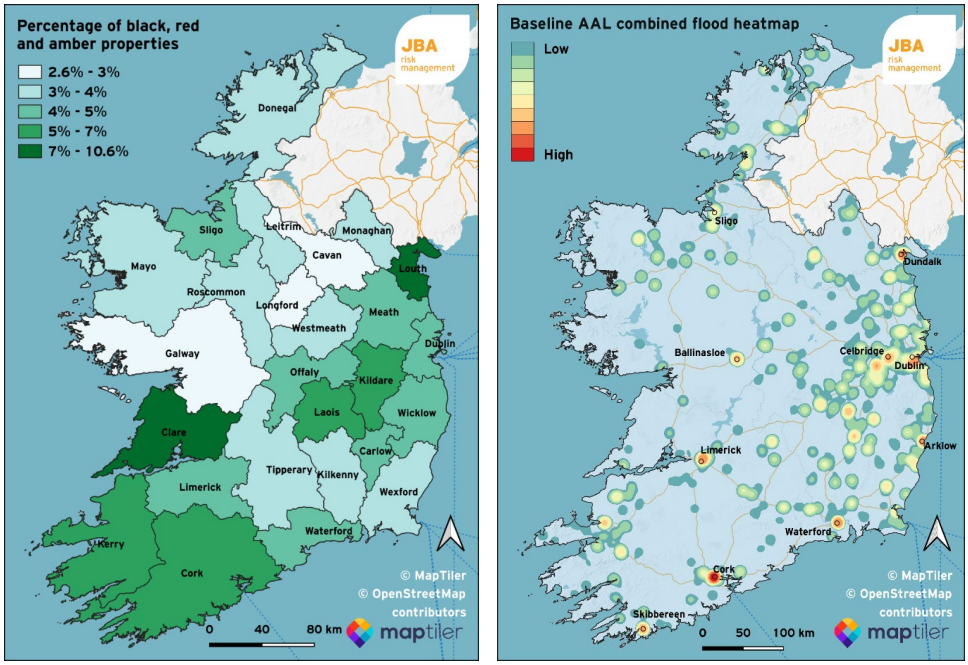
County Level Protection Gap

The protection gap is not evenly distributed across the country, instead, there are areas around the country with very limited access to flood cover, and other areas with where flood insurance is widely available.

Diagram 1 | Concentration of Protection Gap across Ireland



The protection gap is strongly concentrated in particular areas of the country

The protection gap is concentrated in particular counties, Dublin, Cork, Louth, Clare and Kildare. This feature is influenced by two main factors, where floods occur but also the location of more densely populated areas. This concentration of the protection gap means that in some counties, whole villages or towns may be unable to obtain flood insurance while in other areas it is freely available.

The heat map outlines inland flooding losses. Much of the red concentration is close to the coast so should there be any coastal flooding involved in a storm event these losses will likely increase.

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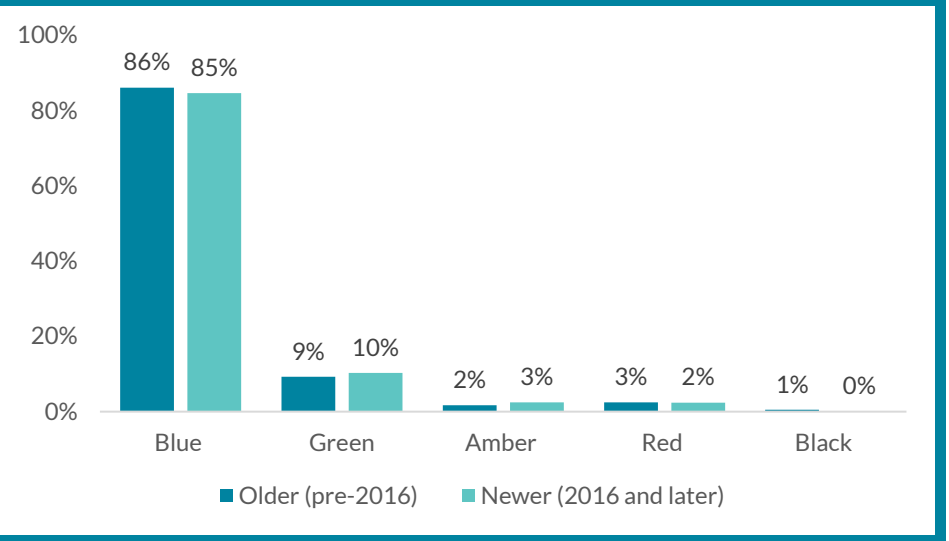
SPOTLIGHT: Are newer buildings more likely to flood?

The OPW introduced Guidelines for Planning Authorities in 2009[8], which specifically address the management of flood risk through the planning process.

In order to consider whether newer buildings are more or less likely to be built in flood-prone regions, the establishment of the Eircode database in 2016 was used as a proxy for the age of buildings. Shown below are the results.

Chart 3 | Flood risk by age of building



There is a small movement from the blue (no risk) category to the green (low risk) category, and a small movement from the red and black (high risk) categories to the amber (moderate) category. When the risk ratings are split into two buckets, low-to-no-risk and moderate-to-high-risk, there is negligible movements between the buckets. However, since there are still some newer properties in the amber and red categories, it does appear that some building is still taking place in flood-prone areas.

It is important to note that flood risk is not the only factor taken into account in deciding where to build. For example, access to infrastructure and services, and conservation of natural and historical sites are also important factors. Flood-specific aspects of planning, such as building level defences, are also not taken into account in the scores underlying this analysis.

[8] https://www.opr.ie/wp-content/uploads/2019/08/2009-Planning-System-Flood-Risk-Mgmt-1.pdf

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How might Climate Change affect the results?

Ireland is likely to see significantly more rainfall in the future due to climate change.

Climate change is not a distant future possibility but a current reality. 2023 was the wettest and warmest year on record in Ireland, and this trend is expected to continue. Met Éireann's TRANSLATE data shows a steady increase in average precipitation, with extreme storms and floods also expected to become more frequent. As global temperatures rise, Ireland can expect drier summers and wetter winters. Winter rainfall could increase by up to 34% in an extreme climate change scenario. This is reflected in our modelling, which shows, for example, that an extreme event costing €2.5bn becomes twice as likely by 2050, moving from a 1 in 200 year event to a 1 in 100 year event.

Modelling Approach

In order to model the effects of climate change, two climate change scenarios were considered: the OPW mid-range and high-end scenarios. These scenarios underpin the OPW's flood resilience plans and are therefore directly relevant to managing Irish flood risk. The scenarios were projected out to 2050. In more detail:

- The mid-range scenario includes a 20% increase in rainfall and a 0.5 meter increase in sea level. This was modelled using the Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway (RCP)[9] 4.5 scenario. This could be considered a probable baseline scenario.
- The high-end scenario includes a 30% increase in rainfall and a 1 meter increase in sea level. This was modelled using the IPCC RPC 8.5 scenario.

In modelling the scenarios, it was assumed that:

- There are no changes to the landscape of Ireland (e.g. building stock, flood defences or land usage)

[9] Representative Concentration Pathways (RCP) are climate change scenarios that project future greenhouse gas concentrations. These pathways (or trajectories) describe future greenhouse gas concentrations (not emissions) and have been formally adopted by the IPCC.

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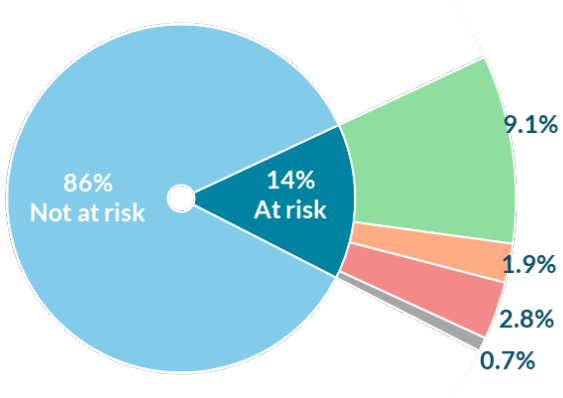
- Insurers' underwriting criteria remained the same.

In line with the quantification of the protection gap today, the flood scores take into account all three flood types, and the average annual loss takes into account inland flooding only.

Results

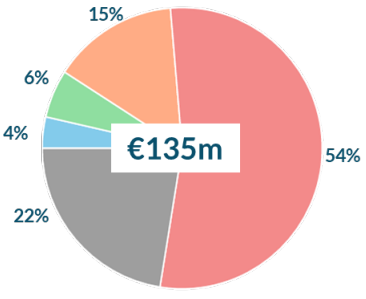
Shown below are the number of buildings and costs associated with the protection gap, taking the effects of climate change into account.

Chart 4 | Number of buildings per flood risk category – Mid-Range Scenario



The number of buildings with limited access to flood insurance increases from 4.8% today to 5.4% by 2050 under the mid-range scenario.

Chart 5 | Average Annual Loss per flood risk category – Mid-Range Scenario



# Buildings	Total AAL	AAL change from baseline
1,728,093	€ 4.9m	+10%
183,959	€ 7.5 m	
38,123	€ 19.7 m	+37%
56,626	€ 73.0 m	
13,514	€ 30.4 m	

The AAL shows a more significant level of change, increasing to €135m under the mid-range scenario, compared to €101m today. Of this €135m, €123m arises on buildings with limited access to insurance. For buildings with access to insurance, the AAL increases by 10%. For those in the protection gap, the AAL increases by 37%.

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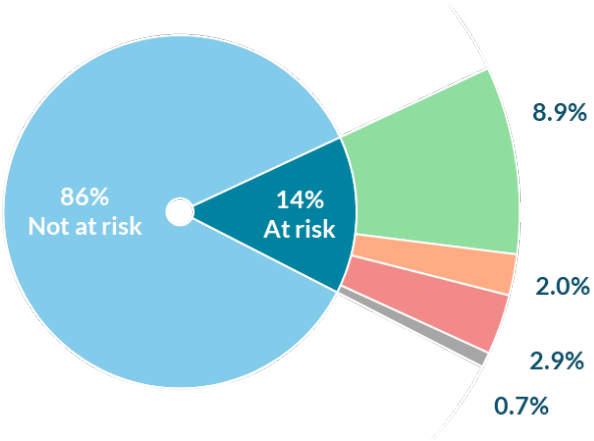
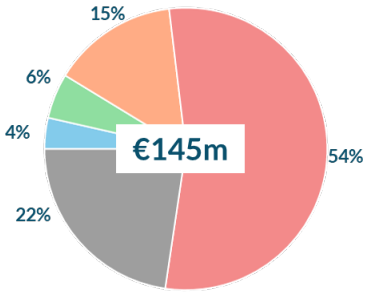
Chart 6 | Number of buildings per flood risk category – High-End Scenario



The number of buildings with limited access to flood insurance increases from 4.8% today to 5.6% by 2050 under the high-end scenario.

Chart 7 | Average Annual Loss per flood risk category – High-End Scenario



# Buildings	Total AAL	AAL change from baseline
1,727,707	€ 5.2m	+10%
180,801	€ 7.5 m	
39,493	€ 20.9 m	+47%
57,929	€ 78.7 m	
14,385	€ 32.9 m	

Under the high-end scenario the average annual loss increases to €145m, compared to €101m today. Of this €145m, €133m arises on buildings with limited access to insurance. For buildings with access to insurance, the AAL increases by 12%. For those in the protection gap, the AAL increases by 47%.

The modelled results indicate that while the areas prone to flooding remain the same, the level of flooding worsens and high risk buildings become even higher risk.

Average annual losses are projected to increase by 44% under a high-end climate scenario. The greatest increase is seen on buildings with limited access to insurance.

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SPOTLIGHT: What about severe floods?

Storm Desmond hit Ireland in December 2015, causing extensive flooding, particularly in the West of Ireland. Flood modelling suggests property losses from inland flooding were approximately €201m. Losses of this magnitude are modelled to occur once every 11 years. The damage caused by Storm Desmond was far more severe in Northern England, where it stalled for three days, breaking the UK's 24-hour rainfall record and causing major flooding. This could be considered a "near miss" for Ireland – a different storm path could have caused much more property damage in Ireland, particularly if it had stalled over a densely populated area like Dublin.

A scenario in which a similar storm had stalled instead over the East of Ireland was considered. In this scenario, the property losses from inland flooding are in the order of €1.1bn, roughly 5.5 times the loss for the historical event. A loss of this scale would put significant financial strain on both the insurance industry and the State.

Storms like this are becoming more frequent due to climate change. An event of this scale could become 33% more likely by 2050.

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What about Coastal Flooding?

Sea levels are expected to rise for all Irish coastal areas due to climate change. Since the early 1990s, sea levels around Ireland have steadily risen by around 2-3mm per year. With half of the Irish population living in coastal cities, increasing sea levels are likely to have a material impact on national flood risk.

Coastal flooding is likely to significantly increase the total annual cost of flooding.

While modelling the losses associated with coastal flooding was outside the scope of this project, a Gamma White Paper[10] published in 2020 considers how coastal flood risk could evolve with climate change. The paper explores a future extreme event, in which a 1 in 100 year coastal flood causes a storm surge of 75cm, on top of a 1m rise in background sea level. The projected losses in this scenario were in the order of €1bn.

This result demonstrates the materiality of coastal flood risk in Ireland, and how climate change could lead to more severe flood events in future.

What other challenges might climate change bring?

There are a number of factors relating to market dynamics and climate modelling that were not considered as part of our analysis, and which could influence the impact that climate change has on the flood insurance protection gap. These are explored briefly below.

Reinsurance availability

Insurers generally cede some of their risk to reinsurers, increasing their capacity to provide cover. At present, reinsurance provides insurers with capacity to offer cover to more households and businesses. However, more frequent flood events will cause higher insured losses, increasing costs for insurers and reinsurers alike. In addition, reinsurance is a global market, and reinsurers' costs will also be impacted by the effects of climate change in other countries. The impact of climate change globally has the potential to affect reinsurers' capacity to provide reinsurance to the Irish market. Reduced reinsurance availability could lead to reduced capacity to cover flood risk in Ireland.

[10] Available at: https://gamma.ie/white-paper-coastal-flooding-climate-change-in-ireland/

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Insurance market capacity

Increased costs together with decreased ability to cede risk to reinsurers could potentially result in insurers having reduced capacity to provide insurance. This could lead to increased premiums for consumers and businesses, and/or changes to insurers' flood risk acceptance criteria, reducing the availability of insurance and further widening the protection gap.

The role of the State

The State plays a vital role in responding to the financial losses caused by flooding. This includes the provision of humanitarian aid to those without insurance, as well as additional costs such as emergency response, clean-up and infrastructure damage.

Our climate change analysis has shown that property damage costs increase under future scenarios, with the highest increase in costs associated with buildings that have limited access to insurance. Extreme events could put further strain on the State's humanitarian aid. Similarly, as the frequency and severity of flood events increases, the other additional costs borne by the State are expected to increase.

Uncertainty in climate projections

There is a high degree of uncertainty when projecting the impacts of climate change beyond 2050. Some of these impacts are expected to be non-linear. The IPCC has outlined that there are certain climate tipping points, whereby a small change in conditions could result in a threshold being crossed that leads to irreversible changes to the climate system. This is not straightforward to model and climate scientists and modellers are progressing their work in this area. However, it is important to acknowledge the possibilities being presented and consider them in the context of how they might impact the protection gap in Ireland in the future.

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Conclusion

Looking to the future, Ireland will face more frequent and severe floods as the effects of climate change become ever clearer. Ireland will need to adapt to this situation, both in terms of physical defences and also financial solutions.

Building flood resilience in the face of climate change will require cooperation and coordination from the all relevant stakeholders involved in flood risk management in Ireland.

Our analysis of the flood risk protection gap has yielded important findings. Today 1 in 20 buildings has limited access to flood cover and this gap is likely to grow in future. Even more troubling, the costs to the State from severe floods are likely to climb significantly in future decades. As with many other aspects of climate change, it cannot be assumed that current approaches to flood risk management will remain viable. There is a serious risk of complacency that must be avoided.

We cannot assume that current approaches to managing flood risk will remain viable.

While this phase of the Central Bank's work is drawing to a close, the flood risk protection gap remains an area of focus for the Bank. We will continue to engage with key stakeholders in relation to tangible action they are taking to address this important issue.

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