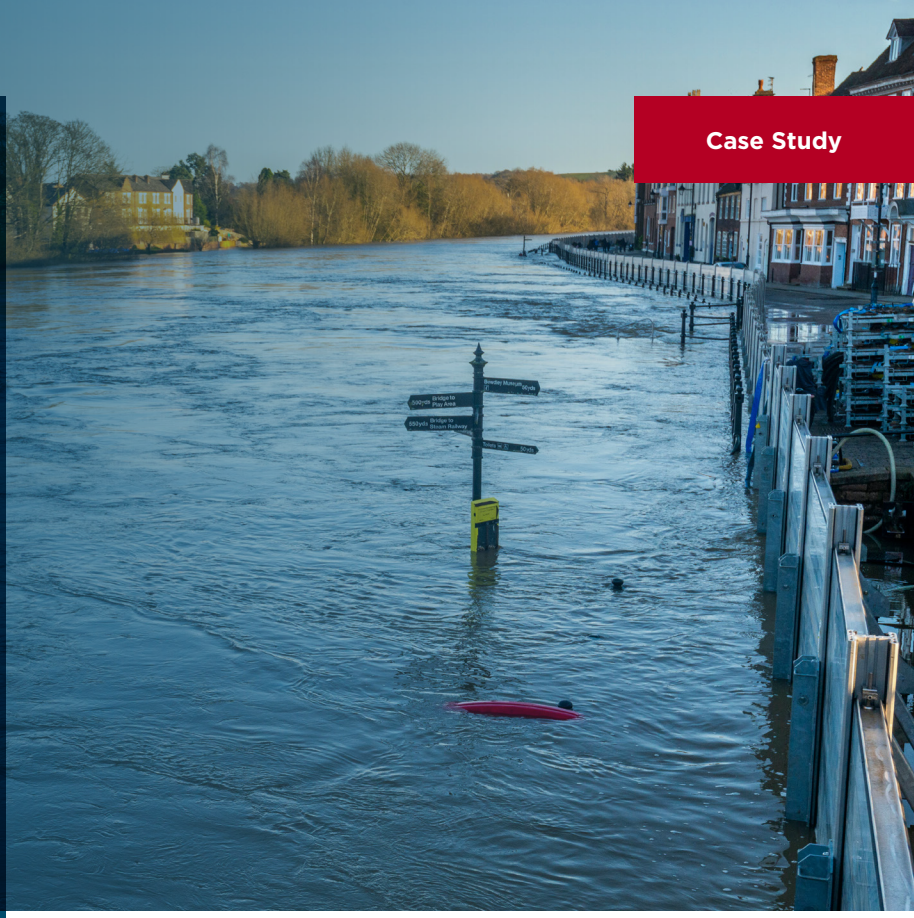
Case Study



Evaluating the Performance of UK Flood Defences Under Climate Change

What is Flood Re?

Flood Re is a reinsurance scheme established as a partnership between U.K. insurers and the U.K. government. Flood Re underwrites high flood risk residential properties that insurers select to enter into the scheme, and it charges subsidised tariffs based on council tax bands rather than flood risk. Flood Re was designed with a finite lifespan and will exit the market in 2039. Flood Re's Transition Plan[1] sets out its vision to support the market in this transition to operation without the scheme.

Moody's RMS™ Products

- Europe Inland Flood HD Models
- Europe Inland Flood HD Climate Change Models

[1] https://www.floodre.co.uk/about-us/reports/#:-:text=The%20Transition%20Plan%202023,time%20we%20exit%20in%202039

Background

Flood Defences

Flood defences play a vital role in protecting people and properties against flooding in the U.K. As climate change increases flood risk over the coming decades, the frequency and severity of floods will increase. This will reduce the effective protection of the U.K.'s flood defences, as the likelihood of flooding overtopping defences increases.

Moody's RMS™ has conducted work in partnership with Flood Re to examine how climate change could impact flood defence outcomes for York, England, and Pontypridd, Wales. The study projects forward to 2040; this is when the Flood Re scheme will have reached the end of its lifespan (in 2039) and the U.K. insurance market will have transitioned back to risk-reflective pricing for flood.

York

Situated in northeastern England, York has a population of around 200,000 people. The city is highly exposed to flooding, primarily from the River Ouse that passes through the city's center and from tributaries. Surface water flooding is also a risk, as seen during the U.K.'s summer 2007 flooding.

The city has been repeatedly impacted by floods in recent years. Boxing Day Floods in 2015 impacted over 600 homes and led to a £45 million ($58 million) defence investment in the York Flood Alleviation Scheme (which concludes at the end of 2023) .

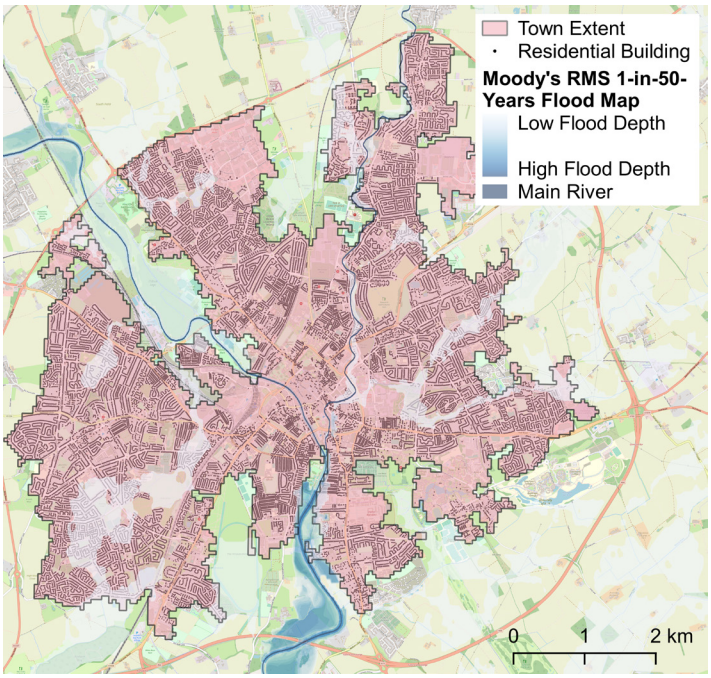
The city has seen recent flooding from Storms Bella, Dennis, and Franklin, among others. York is generally protected to the 100-year level of severity[2], with some limited areas protected above and below this.[3]

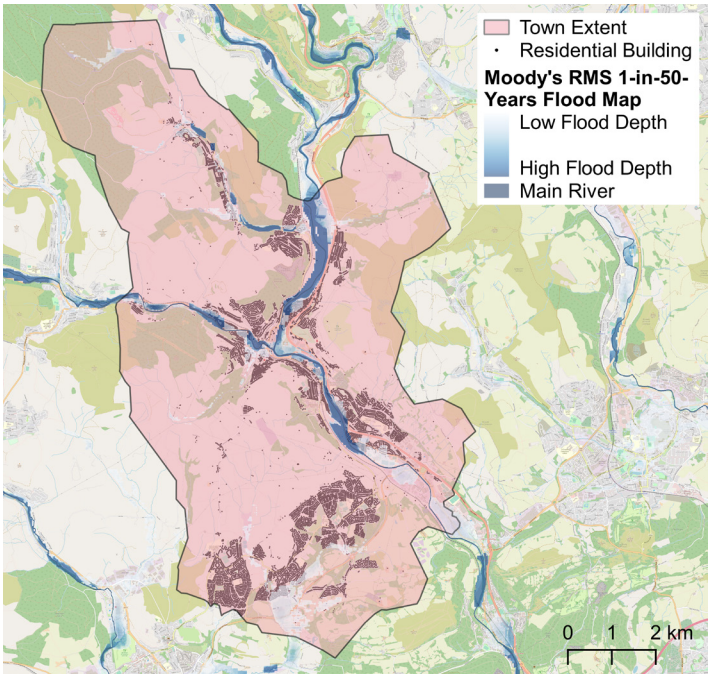
Pontypridd

Situated in South Wales, Pontypridd has a population of more than 30,000 people. Flood risk is characterized by infrequent severe flooding from the River Taff and more frequent but less severe surface water flooding.

Pontypridd was severely impacted by Storm Dennis in 2020, with more than 150 properties flooded and depths of up to 1.8 meters (nearly 6 feet). Flooding was caused by the River Taff overtopping its banks and was exacerbated by surface water from excess rainfall.

The standard of protection of flood defences for Pontypridd varies from the 1-in-25-year level of severity up to a maximum level of 1-in-100 years in the most central areas.[4] This level was exceeded during Storm Dennis, which was the most severe flood event since 1979.





[2]The 100-year return period level of severity is an event so acute that it would not occur, on average, more than once every 100 years over the long term.
[3]The U.K. Environment Agency's spatial flood defences layer – AIMS Spatial Flood Defences – provides comprehensive and up-to-date information on flood defences in England. This (and other) data are incorporated in the Europe Inland Flood HD Models for reflecting and modeling the performance of flood defences in stochastic event.
[4]Natural Resources Wales' spatial dataset – Areas Benefiting from Flood Defences – indicates areas in the country that benefit from flood defences including level of flood protection. This (and other) data are incorporated in the Europe Inland Flood HD Models for reflecting and modeling the performance of flood defences in stochastic event.

Scenarios: Overview

Moody's RMS and Flood Re considered a severe flood scenario for residential properties in York and Pontypridd using the Moody's RMS® Industry Exposure Database for the U.K. Inland Flood HD Model, combined with the U.K. Inland Flood HD Climate Change Model. The study examines the impact of two climate scenarios in 2040 (Table 1) and how strengthening flood defences can offset some of the impacts.

The study considers:

- The cost of property damage for the present day, with existing defences as baseline.
- The impact of a high and low emissions climate pathway on the baseline in 2040, holding other variables[5] constant to illustrate the impact of climate change alone.
- The impact of increasing flood defence standards of protection under two strengthening scenarios, for the high- and low-emissions climate scenarios.

	Current climate baseline	RCP8.5: high-emissions climate in 2024	RCP2.6: low-emissions climate in 2024
With 50% increased defense standard of protection (SoP)	Defence SoP +50%	RCP8.5 and defence SoP +50%	RCP2.6 and defence SoP +50%
With 100% increased defense standard of protection (SoP)	Defence SoP +100%	RCP8.5 and defence SoP +100%	RCP2.6 and defence SoP +100%

Table 1: The case study's scenarios combine the current climate and two Representative Concentration Pathway (RCP) scenarios with two flood defence scenarios

Assumptions

Severe Flood Scenario

The 1-in-50-year return period loss event is chosen, i.e., it is an event of such severity that it would recur, on average, only once every 50 years. For context, the largest U.K. flood event of recent years was the summer 2007[6] flooding, which is estimated as having a return period of between 30 and 45 years. Losses were estimated at £4 billion ($5.1 billion) in 2007 (£6.7 billion ($8.6 billion) in today's values), and the Association of British Insurers estimated 57,000 to 74,000 properties were flooded.

Climate Pathways

Representative Concentration Pathway (RCP) 8.5 is selected as the more pessimistic climate outcome for the 2040 projections.

RCP8.5 describes an emissions scenario leading to warming of more than 4 degrees Celsius by 2100. RCP2.6 is selected as the more optimistic climate outcome for the 2040 projections. It describes a lower emissions pathway leading to warming of less than 2 degrees Celsius by 2100.

Defence Strengthening

Defence standards of protection are expressed as return periods. The study looks at the impact of increasing the return period of standard of protection for fluvial flood defences by 50% and 100%, i.e., protection to a 100-year return period level of severity becomes 150 years and 200 years.

[5]The number, location, and value of properties/exposure are held constant over time.
[6]Chatterton, J., Viavattene, C., Morris, J., Penning-Rowsell, E., & Tapsell, S. (January 2010). The costs of the summer 2007 Floods in England, Environment Agency project number SC070039. https://assets.publishing.service.gov.uk/media/602e9870e90e07660dec0b0a/The_Costs_of_the_Summer_2007_Floods_in_England_technical_report.pdf

Results

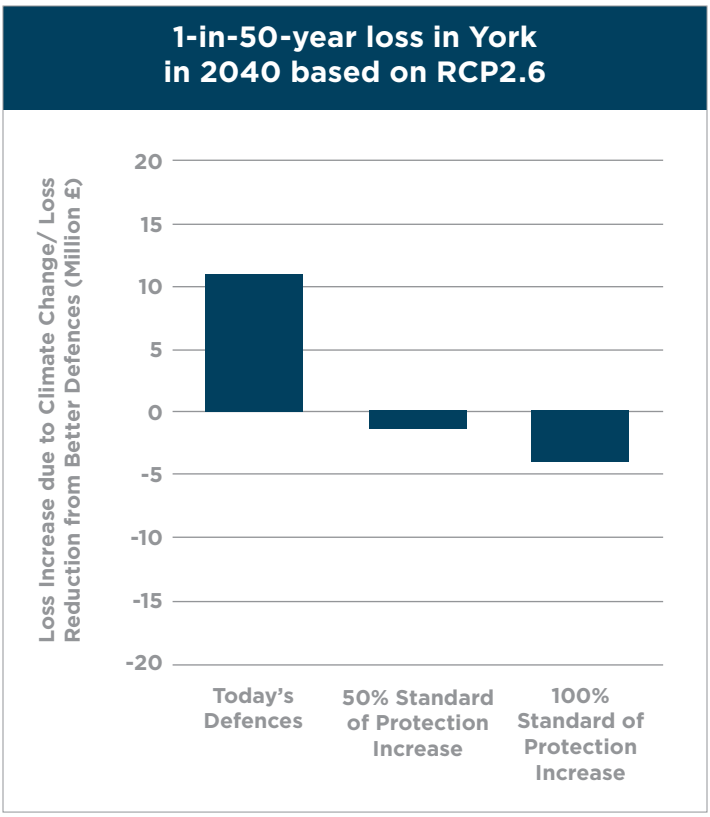
Overall, climate change erodes standards of protection (SoP) over the study period and produces significant increases in loss for our chosen scenario—for both York and Pontypridd.

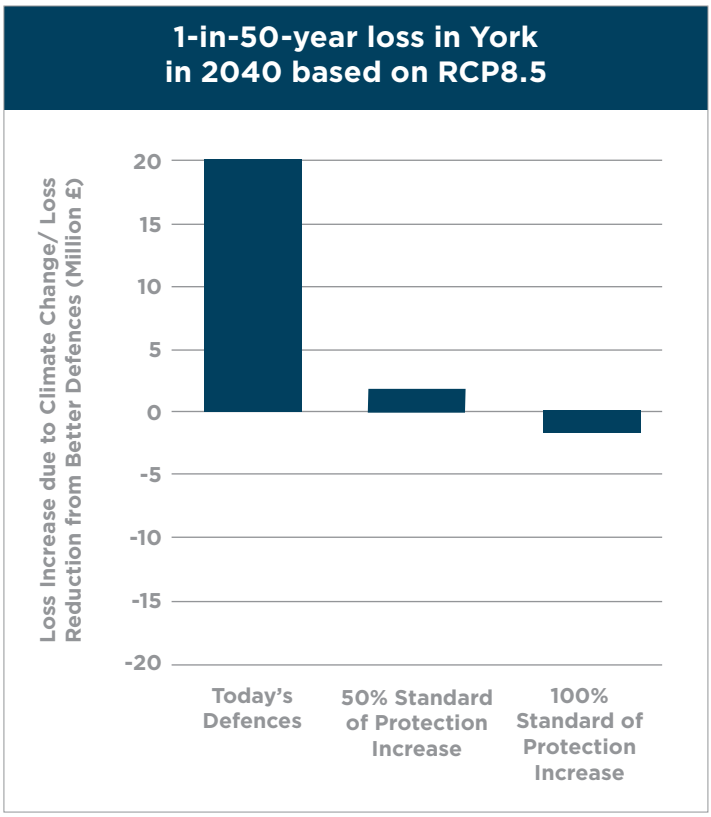
Although York has a large number of households at risk, the city benefits from high standards of flood protection. Our chosen 1-in-50-year flood scenario is largely contained by the defences in the baseline. However, over the study period, climate change erodes the effectiveness of this protection and produces £11 to £20 million ($14.1 to $25.7 million) of additional losses for our scenario.

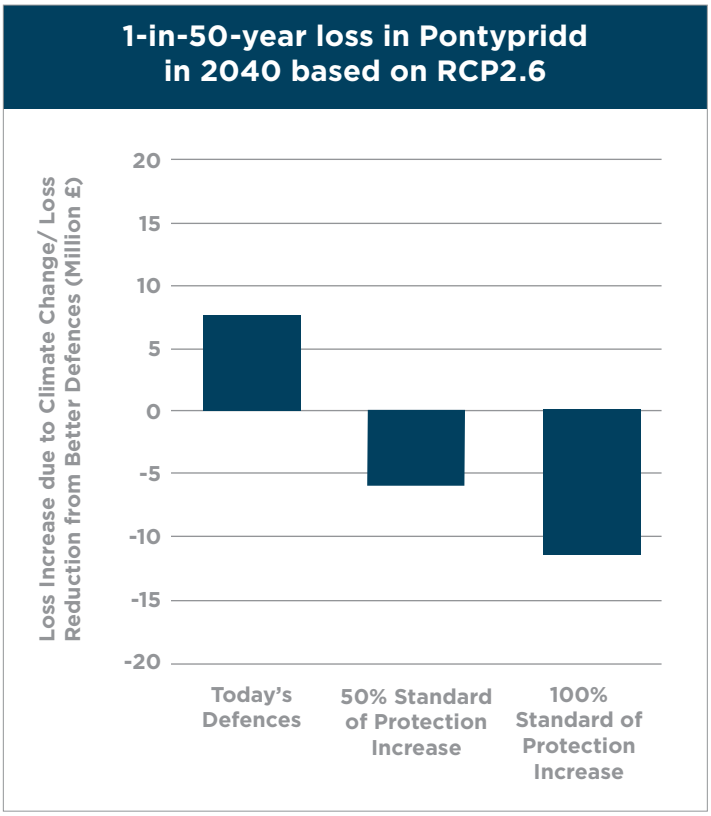
The outcome for Pontypridd is less sensitive to climate change than York. But notably, additional losses over the study period are not far behind the York outcomes despite the substantially lower number of households at risk. This is due to lower standards of flood protection. At the chosen 1-in-50-year flood scenario level, a portion of the losses already originate from overtopping of some of the existing river defences before climate change is considered. There are additional climate-change-driven losses of £8 to £17 million ($10.3 to $21.9 million) for Pontypridd for this scenario.

The strengthening of flood defences offsets these additional losses; however, the two different defence-strengthening scenarios show that the effectiveness of investment varies. A 50 percent increase in SoP leads to the largest loss reduction for both York and Pontypridd, independent of the RCP scenario. Although a 100 percent increase in SoP still leads to a further reduction in loss, the reduction is not as great because even the largest embankments along the main rivers offer no protection against surface water flooding from excess rainfall.

For example, for Pontypridd in the 2040 RCP2.6 scenario, a 50 percent SoP increase compared to existing defences yields a reduction of £14 million ($18.0 million) in losses, while a 100% SoP increase only yields a further £5.5 million ($7.0 million) in loss reduction benefits. This behaviour is similar (Pontypridd: RCP8.5) or even more pronounced (York: RCP2.6 and RCP8.5) for the other scenarios shown. It is important to note that the higher SoP for York means that the city benefits more in the defence-strengthening scenarios than Pontypridd, where the starting point is lower. See Figure 1 (next page) for more details.







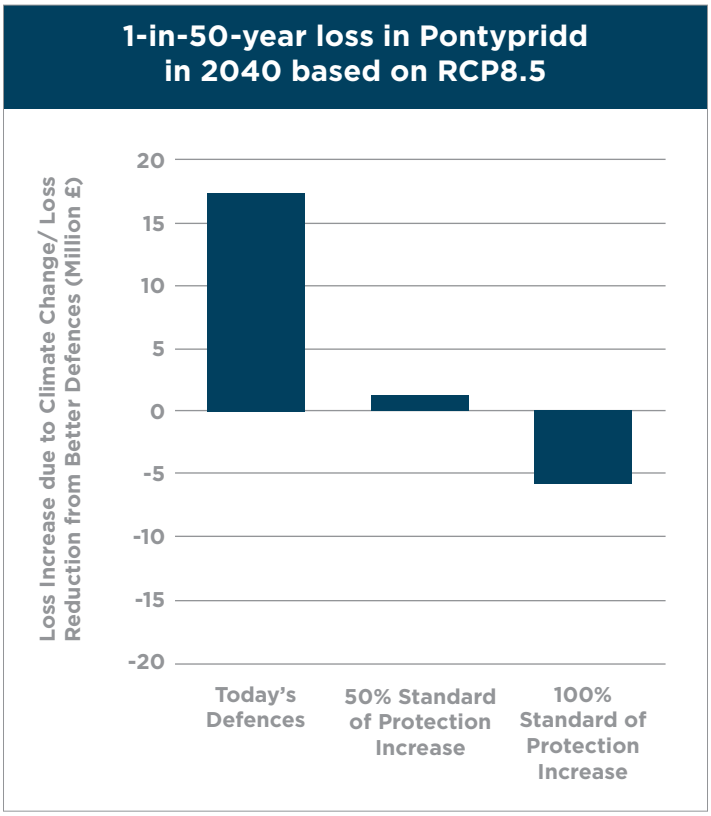


Figure 2: Interplay between increase in loss due to Climate Change, and reduction in loss due to better flood defences.

Conclusions: The Importance and Limitations of Flood Defences

The U.K. is one of the best defended countries in the world for flood risk, and the government has committed more than £5 billion ($6.4 million) to the 2021–27 flood and coastal erosion risk management investment program. However, climate change presents an enormous challenge to defence infrastructure. This study projects that both York and Pontypridd will suffer material additional flood losses as a result of climate change, as defences are overwhelmed by increased flood severity over the lifetime of the Flood Re scheme.

Investment in flood defences to increase standards of protection is one option to mitigate the impacts of climate change. This study shows that additional losses can be offset by defence strengthening, however, significant increases in standards of protection are required to fully offset the additional costs. The study further indicates that investment in defence strengthening is only cost-effective to a certain level, with diminishing benefits beyond a point.

In 2040, the U.K. will be dealing with these projected increases in risk and also with the transition of the U.K. domestic insurance market at the end of the Flood Re scheme. This study shows that investment in flood defences will have an important role to play in the U.K.'s successful transition to a post-Flood Re insurance market for flood coverage. However, defence infrastructure is just one solution amongst multiple adaptations that will be required. For further reducing – and better managing – risk, additional measures such as property-level flood resilience and management of increased surface water risk will be necessary.