



Climate Change, Environment, and Infrastructure Committee, Welsh Parliament: Inquiry on the impact of Storms Bert and Darragh

Met Office submission, 05 February 2025

Introduction

The Met Office is the UK's National Meteorological Service, operating as a Public Sector Research Establishment and an Executive Agency of the Department for Science, Innovation and Technology (DSIT). Through the Public Weather Service (PWS), we provide weather forecasts and warnings to help people stay safe and thrive.

During severe weather, we issue National Severe Weather Warnings, alerting the public to potential impacts from severe weather conditions. These warnings can be issued up to seven days in advance for rain, thunderstorms, wind, snow, lightning, ice, extreme heat, and fog.

Beyond short term weather, the Met Office Hadley Centre provides authoritative scientific advice to governments on climate variability and change. We also deliver a range of wider services and scientific research in key areas such as defence and security, international development, and transport.

Clarification of the role of the Met Office

- **What are its responsibilities?**

As the UK's National Meteorological Service, the Met Office has several key responsibilities. Through the Public Weather Service, we deliver weather forecasts and warnings to help people stay safe and thrive.

The Met Office is responsible for issuing weather warnings, which warn of impacts caused by severe weather through the National Severe Weather Warning Service ([NSWWS](#)). These warnings can be issued up to seven days in advance for various conditions, including rain, thunderstorms, wind, snow, lightning, ice, extreme heat, and fog, and are designed to let people, businesses, emergency responders and governments know what weather is in store and what the impacts of that weather may be.

In February 2023, we also became a Category 2 responder under the Civil Contingencies Act, formally recognising our well-established role in supporting the resilience community,

particularly in response to weather hazards. This work is undertaken by a team of Civil Contingency Advisors (CCAs) based across the UK – including in Wales – supporting local resilience forums (LRFs), emergency responders, and local governments. They provide detailed weather briefings based on local knowledge, participate in coordinating groups, and are often embedded in multi-agency resilience command centres. They also contribute to high-level government meetings during emergencies.

Our work requires close collaboration with partners such as Natural Resources Wales and the Environment Agency, including through our joint Flood Forecasting Centre, which serves England and Wales. We also work with various UK government departments, including Defra and the Cabinet Office.

- **How does the Met Office interact with Flood Forecasting Centre and Natural Resources Wales (NRW)**

The Flood Forecasting Centre was established in 2009 and is a strategic partnership between the Met Office and the Environment Agency. This collaboration combines meteorological and hydrological expertise to forecast river, tidal, and coastal flooding, as well as extreme rainfall that may lead to surface water flooding. The Flood Forecasting Centre operates from the Met Office's Services Operations Centre at Exeter Headquarters, allowing for seamless real-time collaboration. The Centre provides national flood forecasting and guidance services, supporting governments and emergency responders with accurate and timely flood risk assessments. In addition, both the FFC and the Met Office sit on the Defra led Flood Taskforce which includes participating in exercises to improve their collaborative response to weather-related challenges.

The Met Office works closely with Natural Resources Wales, supporting their work managing flood risks and taking action based on severe weather warnings. We provide automated feeds of weather data directly into Natural Resources Wales local models, ensuring accurate and timely information for decision-making. Daily communication between Natural Resources Wales and the Met Office, including a 24/7 direct line for urgent queries, ensures continuous coordination, especially during severe weather events. The Met Office also offers guidance and scenarios, adding human insights to complement model outputs, which helps Natural Resources Wales in planning and response activities.

Both organisations engage in joint training on products and services and engage through a Stakeholder User Group and a Joint Steering Group, providing seasonal briefings and support for LRF exercises. This continuous collaboration ensures that Natural Resources Wales and the Met Office can effectively manage and respond to weather-related issues, benefiting the communities they serve.

- **Is the current multi-level forecasting approach working for Wales?**

The Met Office operates a consistent UK-wide approach to weather forecasting but has different arrangements in place with different flooding partners. While it would not be appropriate for us to comment on the efficacy of the multi-level approach in Wales, we do work closely with partners including Natural Resources Wales and responder groups to ensure the Welsh Public can make the right decisions to stay safe and thrive.

We are dedicated to continuously assessing and improving services across the UK. One example of this is an ongoing project seeking to introduce a Common Warnings Framework in order to reduce any confusion and ambiguity in warnings. This initial phase covers weather and flood and aims to maintain a clear authoritative voice of government agencies. Actions to date include:

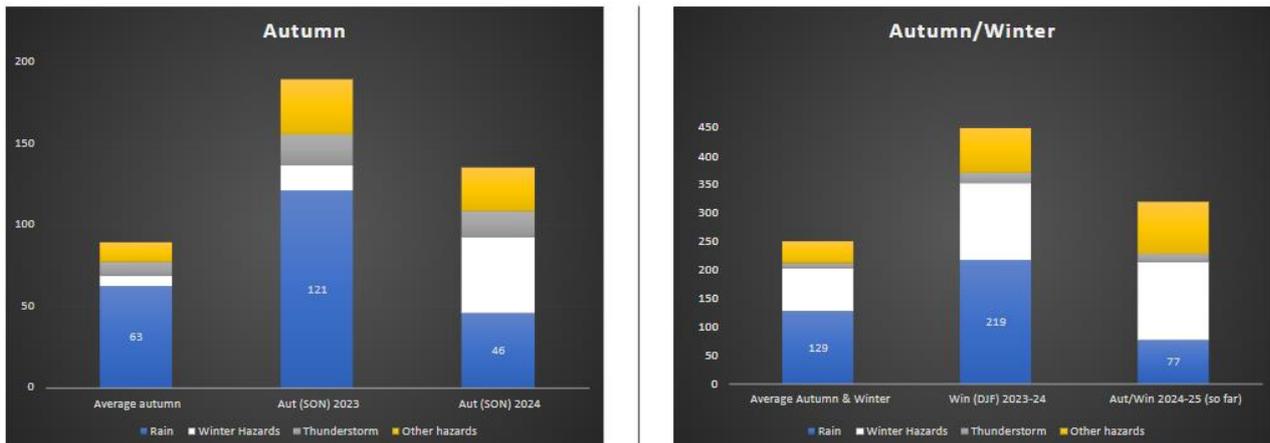
- Flood agency partners have agreed to work together to review and agree a standardised approach to risk assessment. There is evidence that unnecessary historical differences between applications of the 'risk matrix' used across services cause confusion and reduce their overall effectiveness.
- Flood agency partners have agreed to work together to review and agree a standardised language for existing products and agree standards for the future. Language used to describe impacts, likelihoods and risks are inconsistent across the services.
- Flood agency partners have agreed to identify and implement opportunities for standardised approaches to technical standards across our services with a focus on the Common Alerting Protocol (CAP), the recognised international standard for warnings information.

Methodology for weather warnings

- **What is the basis for weather warnings?**

The Met Office issues weather warnings based on a combination of the potential impact of the weather and the likelihood of those impacts occurring. These warnings are designed to inform the public, businesses, emergency responders, and governments about expected severe weather and its possible effects. We provide warnings up to seven days in advance for various weather conditions, including rain, thunderstorms, wind, snow, lightning, ice, extreme heat, and fog.

In any given year the total number of warnings issued will be dependent on the severity of the weather. On average, we issue around 500 warnings a year. Of this, around 60% are low impact, 38% medium impact and 2% high impact. While the total number of warnings may change, the number of days on which warnings are issued shows less variability.



Total number of warnings in Autumn and Autumn/Winter as an average and over the last two years

In addition to the NSWWS, the Met Office, in collaboration with Met Éireann and the Royal Netherlands Meteorological Institute (KNMI), also names storms that are expected to have significant impacts on the UK, Ireland, or the Netherlands. This initiative, known as "Name our Storms," it began in 2015 to improve communication and public awareness of severe weather events. The latest information about storms in the UK as they are named can be found: [UK Storm Centre - Met Office](#).

- **What relative weighting is given to likelihood and severity of impacts?**

The Met Office uses a matrix to determine the level of weather warnings based on two main factors: the severity of impacts and the likelihood of those impacts occurring. This matrix helps us systematically assess and communicate the potential risks associated with different weather events:

- **Severity of Impacts:**

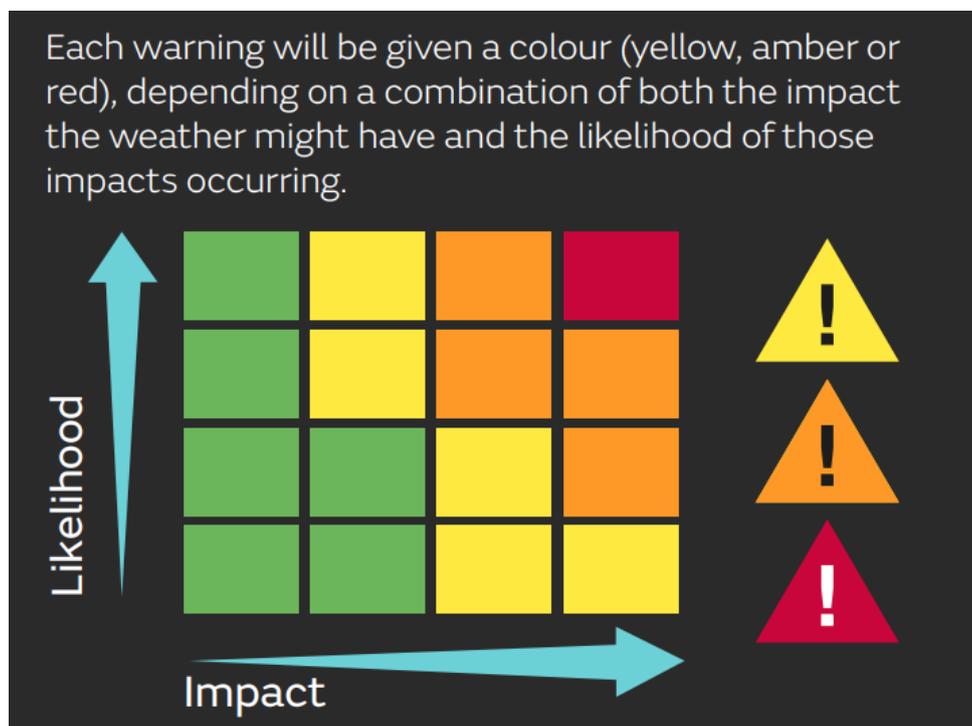
- **Low Impact:** Minor disruptions to daily life, such as light rain causing wet roads or mild winds that might affect outdoor activities.
- **Medium Impact:** More noticeable disruptions, such as moderate rainfall leading to localised flooding, or stronger winds causing minor damage to property and trees.
- **High Impact:** Significant disruptions, such as heavy rainfall causing widespread flooding, or very strong winds leading to extensive damage, power outages, and risks to life.

➤ **Likelihood of Impacts:**

- **Very Low Likelihood:** The event is unlikely to occur, but there is still a small chance.
- **Low Likelihood:** The event is possible but not expected to happen frequently.
- **Medium Likelihood:** The event has a fair chance of occurring.
- **High Likelihood:** The event is expected to occur with a high degree of certainty.

By combining these two factors in a matrix, we can determine the appropriate level of warning:

- **Yellow Warning:** Issued when the impacts are expected to be low to medium, with varying likelihoods. This means that while the weather may cause some disruptions, it is generally manageable, and people should be aware and prepared. High impact yellow warnings can also be issued when the weather could bring much more severe impacts to the majority of people but the certainty of those impacts occurring is much lower.
- **Amber Warning:** Issued when the impacts are expected to be medium to high. This indicates a more significant risk, and people should take action to protect themselves and their property.
- **Red Warning:** Issued when the impacts are expected to be high, with a high likelihood of occurring. This is the most severe level of warning, indicating a substantial risk to life and property, and requiring immediate action to ensure safety.



For example, if we expect a storm with heavy rainfall and strong winds, together with our partners we will assess the potential impacts (e.g. flooding, damage to buildings) and the likelihood of these impacts occurring. If the impacts are expected to be severe and the likelihood is high, we would issue a red warning. Conversely, if the impacts are moderate and the likelihood is medium, we might issue an amber warning.

This matrix approach ensures that our weather warnings are clear, consistent, and based on a thorough assessment of both the potential impacts and their likelihood, helping people and organisations to prepare and respond appropriately.

Met Office warnings are independently verified and verification meetings are routinely held to assess whether the Met Office's warning strategy and individual warnings provided 'Good Guidance'. Internally, we review what was known at the time, decision-making processes, and impacts from the event. Representatives include the Expert Weather Hub (those creating warnings), Civil Contingencies Advisors (those communicating with responders), and key internal stakeholders involved in the event. The outcome of the discussion is presented to the PWS Customer Group for a final decision on whether the warning strategy provided good guidance.

- **How was this methodology applied specifically for Storms Bert and Darragh in Wales?**

For Storm Bert, the methodology indicated a yellow warning due to the expected impacts and their likelihood. Ahead of the storm had been a relatively long dry spell for the time of year, which gave an opportunity for the ground to begin to dry, therefore despite the forecast indicating potential for heavy rainfall in some areas, the overall impacts were assessed as moderate.

In contrast, ahead of Storm Darragh the forecasts indicated extremely high winds and heavy rain, which posed a significant risk to life and property. The impacts were deemed severe, and the likelihood of these impacts occurring was very high. Wind was a significant concern, and so a red warning was issued for high winds across parts of Wales and southwest England during the morning of 6 December, alongside more widespread amber warnings for wind.

- **Why was a yellow warning given for Bert, and a red warning given for Darragh? Was a more precautionary approach taken following the impact of Storm Bert?**

A yellow warning was issued for Storm Bert due to the expected impacts and the available evidence at the time. The forecast indicated significant rainfall and strong winds, but the flood modelling did not support an upgrade to an amber or red warning. The yellow warning was deemed appropriate to indicate the potential for disruptive weather while maintaining

consistency with the impact assessments. Strong messaging and storm naming were used to highlight possible impacts and encourage precautionary actions.

In contrast, a red warning was issued for Storm Darragh due to the forecast extreme wind speeds and high likelihood of for life-threatening conditions and severe impacts. Wind gusts of 90 mph (144 km/h) or more were forecast for parts of Wales and southwest England, leading to significant disruption and potential danger to life. The red warning was necessary to ensure that the public and responders were adequately prepared for the severe impacts.

While both storms were complex multi-hazard events, the forecast impacts and likelihood of these occurring were different. We followed our best practices and assessed each event independently and the warnings reflected these differences.

- **How are these warnings and their basis communicated to relevant stakeholders in Wales?**

The Met Office has a UK-wide remit, and our services cover all the nations and regions of the UK. In terms of our services to the resilience community, we work with the UK Government, with the Devolved Governments and with local resilience groups, as is our role under the Civil Contingencies Act. For flooding we work closely with the responsible agencies in each nation, and have a key role in the structures, agreements and shared aims by which we all collaborate, such as the UK Flood Incident Leadership Group and the Common Warnings Framework.

Our warnings are communicated in a number of ways in order to ensure that members of the public, emergency responders and LRFs have access to vital information to make decisions and stay safe:

- **Public** – Warnings are communicated through our media partners (broadcast and print), across all of our social media channels, and through notifications on the Met Office app, by email, and through other devices such as Amazon Alexa and through European collaborations which allows warnings to reach Apple and android phones.
- **Responders and LRFs**– The Met Office has a network of Civil Contingency Advisors across the UK who engage at all levels of Government (UK / Devolved / Local) as well as with relevant agencies, local resilience forums and emergency responders ahead of and during severe weather events. Actions include but are not limited to:
 - Proactive advisory emails to LRFs in every region, and attending telecons in advance and during severe weather, including Pre-Event Assessment Telecons, Flood Advisory Service telecons, Tactical Co-ordination Groups, Strategic Co-ordination Groups and occasionally comms groups. In Wales, the advisory emails

are also sent to Welsh Government, and in Scotland they will include Scottish Government. Representatives from these Governments may also be in the telecons.

- Senior CCAs send advisory emails to COBR Unit normally when we reach medium impact YELLOW warnings or when we can see something potentially more severe on the horizon. These advisory emails can also be accompanied by a phone conversation. If there is a likelihood of escalation to AMBER warnings then we will also message across Government which reaches many Lead Government Departments (LGDs) including MHCLG, DSIT, DCMS, DEFRA, DfT, UKHSA, DHSC and DESNZ.
- In response to severe weather, there may be national telecons set up and the Senior CCAs will brief into these. These telecons include the Winter Resilience Network, Scottish Government Resilience Room, National Flood Advisory Service (Wales), Wales Civil Contingencies Committee, DEFRA LGD or National Flood Response Centre, and COBR, all of which have representatives from most LGDs.

- **The First Minister of Wales said that conversations took place between the Met Office/ Natural Resources Wales and the Welsh Government after Storm Bert to discuss the warning framework. What were the outcomes of this meeting?**

A short roundtable meeting was held immediately after Storm Bert between the Met Office, Welsh Government and NRW. The discussions were centred around the immediate impacts of the storm, including an overview of the forecast, observed impacts and how the different agencies worked together both ahead of, and during the event. A similar meeting was also held shortly after Storm Darragh. We welcomed both discussions and would welcome the opportunity for further post-event discussions with the Welsh Government in the future.

Wider climate perspective

- **Are the models used for forecasting still fit for purpose in a changing climate?**

Yes. From a weather modelling perspective, our current systems integrate real-time observation data with an understanding of the physical processes of the atmosphere to generate forecasts. This integration allows us to create accurate and reliable weather predictions. The Met Office uses advanced Numerical Weather Prediction (NWP) models, such as the Unified Model, which is highly configurable for meteorological prediction across various timescales, from short-term weather forecasts to long-term climate projections. This model is regularly updated to incorporate the latest scientific research and technological advancements.

The Met Office employs high-resolution models that provide detailed forecasts. For example, the UKV model has a high-resolution inner domain with 1.5 km grid boxes, allowing for precise predictions of localised weather.

Ensemble forecasting techniques are used to address uncertainties in weather predictions. By running multiple simulations with slightly varied initial conditions, the Met Office can provide a range of possible outcomes and their probabilities, enhancing the reliability of forecasts. This approach helps in understanding the range of potential weather scenarios and their likelihoods. The models integrate real-time observation data from various sources, including satellites, weather stations, and radar systems. This continuous data feed ensures that the models reflect the most current atmospheric conditions. The integration of real-time data is essential for maintaining the accuracy and relevance of weather forecasts. The models account for climate change by incorporating the physical laws that govern the atmosphere. As global temperatures rise and weather patterns shift, the models are adjusted to reflect these changes, ensuring that weather forecasts remain accurate and relevant.

This adaptation is crucial for predicting weather in the context of a changing climate. For example, in July 2022 Met Office models were able to accurately forecast a record-breaking UK heatwave – which saw UK temperatures breach 40°C for the first time – two weeks in advance. This allowed us to rapidly engage across governments, the wider public sector, LRFs and industry to drive pre-emptive action ahead of the heatwave.

In the context of flood forecasting, the introduction of ensemble forecasting could provide real value. There could be an opportunity for the Met Office to work with our partners to ensure the value of ensemble modelling flows all the way through the chain to better quantify uncertainty in meteorological, hydrological and impact forecasting, then ultimately warnings and alerts.

The Met Office continuously validates and improves its models based on real-world observations and feedback. This iterative process helps maintain the accuracy and reliability of weather forecasts. By regularly updating and refining the models, the Met Office ensures that they remain robust and adaptable to new challenges.

- **How has frequency and intensity of extreme weather events changed over time, and what are the predictions for how this will change in future?**

Although rainfall observations show large variability in annual, seasonal and decadal rainfall, it has generally become wetter, particularly during winter.

Climate projections indicate that on average, winters will become wetter and summers drier, though natural variability will mean we will continue to see individual years that don't follow this trend.

As our atmosphere warms it can hold more moisture, roughly 7% more per 1°C of warming. This can lead to more intense and frequent downpours. In autumn, the UK will likely see more days with rainfall totals over 50mm, particularly for western areas of the UK. For summer, despite an overall drying trend, there will likely be future increases in the intensity of heavy summer rainfall events (see 'Intense rainfall from thunderstorms' section).

In the UK, a recent [attribution study](#) has shown that climate change has made rainfall during storms more intense through the autumn and winter. The report found that the UK rainfall in the winter season of 2023-24 was 20% more intense due to human-caused climate change. A Met Office [review](#) of the UK's climate in 2024 also found that last year was relatively wet, with 7% more rainfall than average, making it the UK's 17th wettest in a series going back to 1836. The review also highlighted that the winter half-year from October 2023 to March 2024 was the wettest on record for both England and Wales, including in the long-running [England and Wales Precipitation series \(EWP\)](#), which dates back to 1766.

This trend is expected to increase further in a warming climate, however it is important to note that there are other factors that contribute to flooding, such as land use, local hydrology and preceding conditions.

Further reading/ references

[Weather warnings guide - Met Office](#)

[Flood Forecasting - Met Office](#)

[Advances in flood forecasting – The Environment Agency / Met Office ...](#)

[Natural Resources Wales / Flood risk management annual report 2023 to 2024](#)

[Met Office: Rain Gauge \(3rd Party Data\) - metadata.naturalresources.wales](#)