Factsheet

UK Centre for Ecology & Hydrology

Flooding

Key facts and figures

- The Environment Agency says 5.7 million (1 in 6) properties in England are at risk from flooding
- Climate change makes extended periods of extreme winter rainfall 7 times more likely
- Parts of northern Britain are seeing the biggest increases in flood severity in Europe
- Rainfall caused by extreme thunderstorms could increase 25% in the UK by the 2050s

Photo: iStock

Q What is flooding and what causes it?

A Flooding involves overflowing or accumulation of water onto land that is normally dry. It can happen within minutes and may last days, weeks or many months. Flooding is a complex phenomenon that can be caused by a range of different factors. While floods are often triggered by heavy rain falling in a short amount of time, the extent and duration of flooding are affected by, for example, the amount of rainfall, its duration and precisely where it falls, the type of land surface and how saturated it is, and any flood management schemes in place. These complexities make it challenging to predict the precise nature of each flood event in detail.

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Q What are the different types of floods?

A

- **River (or fluvial) flooding**, which is common in the UK, happens when the flow of water exceeds a river channel's capacity and spills over the banks onto nearby land.
- High tides and stormy weather increase risk of **coastal flooding**, affecting many areas of the UK. As well as floodwater and waves, salt in seawater can damage buildings.
- **Surface water (or pluvial) flooding** follows heavy rainfall, often caused by thunderstorms, when excess water cannot be absorbed by the ground or be spread over a large area, so accumulates in ponds on the surface. This often occurs in urban areas due to artificial impermeable surfaces eg concrete, roads and paths and can worsen when drains become blocked.
- Blockages in underground pipes caused by heavy rainfall or large objects can cause **sewer flooding**.
- **Groundwater flooding** can happen when the water table rises above ground level due to prolonged heavy rain. Water flows over the surface and may rise into buildings.

Surface water flooding. *Photo:iStock*

- **Overflowing reservoirs or dam breaches** can cause flooding but are rare in the UK.
- **Snowmelt flooding**. A change in weather patterns brings warmer temperatures and rainfall that rapidly melts snow, potentially releasing a lot of water. This has caused some of the biggest UK river floods including in 1947. As the climate has warmed and there is less heavy snow, snowmelt floods are less common in the UK, though still affect the Scottish Highlands and upland areas of England and Wales, as well as parts of the world with colder climates.
- **Flash flooding** is often caused by heavy rainfall as a result of thunderstorms but refers to any type of flood event that occurs quickly, usually within three hours.

Q Why can flash flooding occur after hot weather?

A

Hot weather can contribute to the development of thunderstorms. These storms can bring intense rainfall over a short period, which may overwhelm the capacity of drainage networks or soils to absorb water, leading to flash flooding.

Hot weather can dry out and weaken vegetation, reducing its ability to absorb and slow down water. The ability of soils themselves to absorb water may change with drought. Absorption can increase when soils crack or decrease if soils seal, trap air or repel water like a Gore-tex coat. Soft, gentle rain at the end of dry periods is preferable to rewet soils and avoid flash flooding.

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Q Is flooding becoming more common in the UK?

A Studies of historical data show a trend towards more extreme weather conditions on average in the UK, though with regional differences, with the north and west becoming wetter. International research involving UKCEH has linked the run of wetter summers in the UK in the late 2000s/early 2010s, including the summer 2007 floods, to the variability in Atlantic sea-surface temperatures.

Parts of northern Britain are seeing the biggest increases in flood severity in Europe – with the largest flood of a year rising 11% per decade, according to a large-scale analysis of historic data by European institutes including UKCEH (Blöschl et al, 2019).

Q Is climate change causing more flooding?

A We do not yet know conclusively how much the prevalence of recent floods is down to human-induced climate warming and how much is down to the natural patterns of hydrometeorological variability – the reality is that floods are driven by a combination of both.

However, there is growing scientific evidence of a connection with climate change which, in general terms, is because a warmer atmosphere can store more water. The Blöschl et al. study provides some of the clearest evidence yet, at the European scale, of the link between climate change and increased severity of flooding.

It remains difficult to conclusively attribute long-term trends in flooding to climate change, but a connection has been made for various flood events. Research involving UKCEH indicate the widespread UK flooding in 2013/2014 was made more likely by human-driven climate change. Other researchers made a similar link regarding the winter 2015/2016 floods.

The Met Office says extended periods of extreme rainfall are seven times more likely as a result of human emissions of greenhouse gases.

Flooding in Oxford in January 2014.

Extreme flooding far exceeding previous records often takes residents and experts by surprise, resulting in severe damage and loss of life.

However, a European-wide study involving UKCEH found it is possible to predict these events by pooling and analysing data from rivers in areas with similar climates in Europe. In this study, the scientists say it is essential to look outside national boundaries.

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Q How can we improve preparations for upcoming flood events?

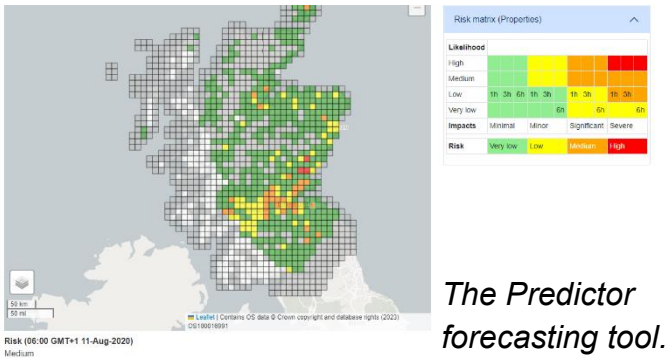
A Earlier guidance and warnings enable more effective responses to flood events and action to limit the damage to homes, businesses, infrastructure and public services.

UKCEH scientists work with UK flood warning agencies to provide computer software and expertise to better forecast and understand flood risk, as well as predict possible impacts. This supports improved flood warnings for the public and better decision-making by emergency responders, energy and water companies and transport operators.

Using Met Office forecasts, the UKCEH's Grid-to-Grid (G2G) model divides the UK into 1km x 1km areas, then estimates river flows and the probability of flooding in each area.

Meanwhile, forecasting tools improve predictions by combining the likelihood of flooding and the potential impacts.

The PREDICTOR tool, developed by the Scottish Environment Protection Agency, Met Office and UKCEH, has been trialled in Scotland, providing new insights into the real-time flood risk for properties and transport.



The Predictor forecasting tool.

In 2023, improved forecasting enabled councils to evacuate homes in advance of Storm Babet and Transport Scotland closed the A90 before flooding for the first time.

UKCEH is involved in flood forecasting projects in the UK, Europe, Africa and Asia, informing flood risk management by government agencies, communities and farmers, as well as helping guide emergency planning and urban development decisions.

Q What will happen in the future?

A Future projections suggest the UK may experience wetter winters and summers that are hotter and drier than at present but with periods of more intense rainfall. There are also likely to be increases in river flooding across Scotland and west coast of Great Britain, though there is less certainty over future projections for the southeast..

Climate change is also expected to increase the magnitude and frequency of surface water flooding across the UK, albeit in some places more than others. Analysis based on Met Office climate projections indicates rainfall totals for extreme storms lasting up to three hours could increase by 25% in the 2050s compared to now.

The increased risk of surface water flooding will be exacerbated by more development, making surfaces impermeable and creating a 'perfect storm', with more rainfall and less capacity to manage it. Coastal flooding is likely to get worse due to the combined effects of higher sea levels and more extreme storms.

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Q What are the risks of building on floodplains?

A

Floodplains are areas adjacent to rivers where overflowing water naturally goes, so carefully planned measures are needed to help prevent properties on this land from flooding. There is also a risk that building on floodplains and creating impermeable surfaces, as well as constructing defences to protect properties, could result in increased flooding downstream.

Development on floodplains also poses a risk to their important role within an ecosystem. These benefits include providing a natural habitat for species, filtering water by capturing sediment and absorbing nutrients, and also storing carbon.

Q How is UKCEH science supporting long-term plans to prevent flood damage?

A

UKCEH collates, verifies and analyses river flow data from measuring stations across the UK, managing the National River Flow Archive, which provides many decades of records and information such as a station description, catchment rainfall and land cover. These data underpin much of the hydrological research and flood risk planning in the UK, used by researchers, water companies, Environment Agency and other government bodies.

Our analysis of data and modelled projections of river flows across the UK up to the year 2100 informs national and local decisions on flood management/defences and drainage design.

UKCEH research led to the development of:

- the Flood Estimation Handbook, which provides the UK standard techniques for estimating the frequency of flooding from rivers and directly from extreme rainfall.
- the FEH Web Service, which delivers data on the climate, soils, land cover and use, and rainfall for all UK catchments.

UKCEH is leading the £38m Floods and Droughts Infrastructure (FDRI) to transform our understanding of hydrological processes in different parts of the UK and increase our resilience to extreme weather events.

A radio-controlled survey boat and drone.

Funded by UKRI-Natural Environment Research Council, it will combine fixed instruments with mobile equipment, such as drones and radio-controlled survey boats, that will be deployed to different areas during floods and droughts.

FDRI will produce an extensive range of new measurements relating to evaporation, soil moisture, weather, groundwater and river flows across several UK catchments. This will enable researchers to improve computer models to predict when and where floods and droughts will happen, and how severe they will be.

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Q What action can be taken to prevent flooding?

A A range of flood management solutions – including natural methods, artificial hard defences and emergency planning – are necessary to better manage flood risk.

Restoring degraded peatlands and saltmarshes can reduce risks. Peatlands slow flow of water from uplands and provide floodplain storage in the lowlands, while saltmarshes act as natural buffer zones, reducing height and energy of waves before they reach properties, roads and buildings.

UKCEH has been undertaking research into natural flood management for many years in experimental catchments, including Plynlimon. Our scientists have been involved in research investigating the effectiveness of natural methods to mitigate flooding along the Thames and in European catchments.

While unlikely to have a major impact during the most extreme events, natural features can help prevent or control flooding for relatively small and frequent flood events by reducing the volume and speed of water entering river channels.

Methods of natural flood management (NFM) include:

- The use of floodplains or retention ponds to store water.
- Planting trees to reduce rainfall runoff.
- Soil bunds (banks) to hold back runoff.
- 'Leaky dams' to slow the river flow and increase connectivity with floodplains.

Farming practices to improve water storage and capacity, slow the speed of water and reduce runoff can include:

A leaky dam at a NFM project involving UKCEH in West Oxfordshire.

- Less ploughing and managing vehicle movements over soil.
- Reducing density of livestock on land.
- Increasing the amount of organic material in soil (ie by adding decaying plant material and manure).
- Planting 'cover crops'.

Permanent and temporary artificial defences can protect thousands of properties during major floods but may provide a misleading sense of security that an area will be safe from all flooding. Impacts of surface water flooding on homes and businesses will increase if flood-prone areas continue to be developed or are not redesigned to mitigate the risks.

The 'sponge cities' in China incorporate a mixture of green infrastructure (trees, lakes and parks) to retain and absorb water together with 'grey infrastructure' (eg drainage systems) to enhancing storage.

Increasing the capacity and resilience of the sewerage network to cope with the impacts of climate change and a growing population would reduce overflowing from drains, though it can be very costly.

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