U.K. Summer 2007 Floods

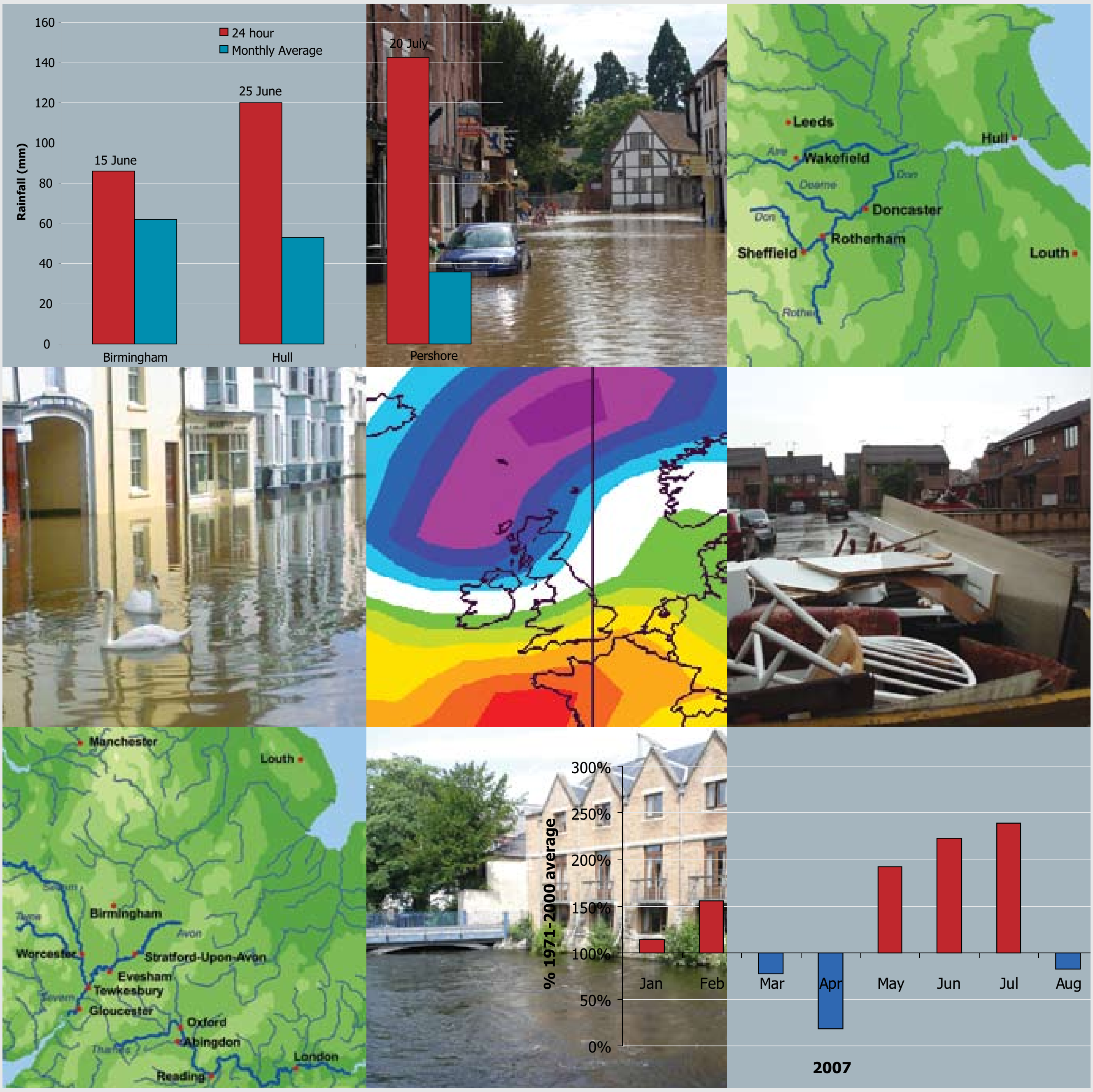

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The summer of 2007 has been the wettest summer in England and Wales since precipitation records began in 1766. During June, July, and August a succession of depressions tracked over the U.K., bringing heavy rainfall and triggering multiple flooding events. The floods ranged from small, localized flash floods to widespread events affecting major river basins. Two particularly large floods hit within just four weeks of each other. First, the northeast of England was badly affected following heavy rainfall on June 25, which caused flooding in cities and towns such as Sheffield, Doncaster, Rotherham, Louth, and Kingston-upon-Hull. Some areas were hit again by further flooding after more severe rains on July 20, which affected a much larger area of central England, including Oxford, Gloucester, Tewkesbury, Evesham, and Abingdon. These have been the most severe floods in 60 years since the March 1947 snowmelt floods, and the effects of the summer 2007 floods on some major rivers, such as the Lower Severn, have been comparable to the 1947 event.

Figure 1: Flooding in Toll Bar, Yorkshire after June 25, 2007 rainfall event

The summer floods have resulted in the largest flood insurance losses in the U.K. to date. As of September 2007, close to 60,000 claims have been reported and RMS estimates total insured losses to be in the range of £2.25–£3.25 billion from the two major flood events. Flood insurance was introduced into standard insurance policies in the U.K. in the 1960s, and while the summer 2007 floods were not as physically extensive as the 1947 flood, the two major summer 2007 flood events exceed the previous largest insurance flood loss, which was caused by the November 2000 floods. This report reviews the summer 2007 flooding events in the context of the key drivers of the flood and the losses together with the implications for the insurance market and catastrophe flood risk modeling.

INTRODUCTION

The floods of summer 2007 were linked to a pattern of very wet and unstable weather across the U.K. over the course of several months. The unseasonably wet weather began in May and continued throughout the summer, with record-breaking rainfall totals in June and July. Exceptionally intense rainfall events caused severe flash flooding in many areas across the U.K. and, as catchments became saturated, swollen rivers overtopped their banks in several major river basins.

Intense heavy rainfall is not unusual during the summer, but in 2007 the frequency and spatial extent was unprecedented. During this period, there were two exceptional rainfall events on June 25 and July 20 that caused widespread flooding across England (Figure 3). Table 1 presents a time series of the summer flood events, of which this report focuses on the two biggest and most devastating events — the June 25 and July 20 floods.

This report discusses the characteristics, drivers and impacts of the summer 2007 flooding events. At the time this report was published (mid-September 2007), the insurance market, the Environment Agency, and other government bodies were still evaluating the full extent and impact of the floods. This report, which summarizes the damage and cause of these major flood events, is based on the information available at the time.

During the summer floods, RMS sent out several

Date of Event(s)	Locations Flooded	Flash Flooding	Major River Flooding
June 1–7	Buckinghamshire (E)	√	
June 8–14	Lancashire (E); Northern Ireland, Ceredigion (W)	√	
June 15–21	County Durham, Devon, Herefordshire, North and West Yorkshire, Shropshire, Worcestershire (E); Ards, Down, North Down (NI); Ayrshire, Lanarkshire (S); Ceredigion (W)	√	√
June 22–28	Yorkshire, Lincolnshire, Humberside, Derbyshire, Nottinghamshire, Shropshire, Worcestershire (E); Peeblesshire (S); Denbighshire, Flintshire, Monmouthshire, Wrexham (W)	√	√
June 29 – July 5	Buckinghamshire, Lancashire, West Yorkshire (E); Antrim (NI); Midlothian, Moray (S)	√	
July 13–19	County Durham, Cumbria, Lancashire, North Yorkshire, Worcestershire (E); Coleraine, Larne (NI); Ayrshire, Dumfriesshire, Ross and Cromatry (S); Denbighshire (W)	√	
July 20–26	Bedfordshire, Berkshire, Buckinghamshire, Cambridgeshire, Dorset, Gloucestershire, Greater London, Hampshire, Herefordshire, Hertfordshire, Lincolnshire, Northamptonshire, Oxfordshire, Shropshire, Warwickshire, West Midlands, Wiltshire, Worcestershire (E); Newport, Monmouthshire, Powys, Torfaen, Glamorgan (W)	√	√
August 20–21	Devon, Kent	√	

Table 1. Summary of 2007 June–August Floods (E: England, NI: Northern Ireland, S: Scotland, W:Wales)

Figure 2: Flooding observed in Tewkesbury during RMS reconnaissance surveys

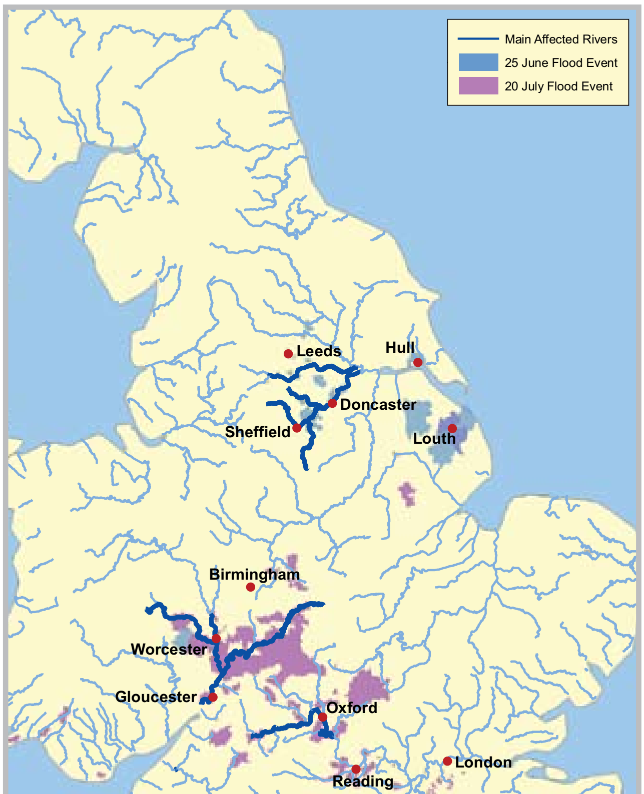


Figure 3: Flooded postcode sectors from June 25 (blue) and July 20 (purple) flood events collated by RMS Catastrophe Response, from a combination of RMS field reconnaissance, media reports, and other Web reconnaissance information. Each whole postcode sector is unlikely to have flooded everywhere, especially in rural areas, where postcode sectors cover a larger area

reconnaissance teams to survey the damaged areas and speak to residents and businesses about their experience. The teams, which included seven flood and vulnerability specialists, visited Doncaster, Sheffield, Barnsley, Catcliffe, Tewkesbury, Evesham, Oxford, Abingdon and Pangbourne. Information gathered from the reconnaissance surveys has been used throughout this report, in particular to inform the assumptions when deriving loss estimates for the events which are discussed within the report. ■

THE SUMMER 2007 U.K. FLOOD EVENTS

The two severe rainstorms of June and July caused widespread fluvial and flash flooding across England and parts of Wales (Figure 3). In both events, the flooding had distinct phases: flash flooding with surface runoff, and extremely high flows in small responsive catchments followed by extensive floodplain inundation as the runoff concentrated along the major river basins. These two events are discussed in more detail in this section.

Flash flooding is defined as the result of heavy or excessive amounts of rainfall within a short period of time, usually less than six hours, causing water to rise and fall rapidly. It includes sources of flooding from small rivers with rapid response times to rainfall, together with overland flow, which in the majority of cases is caused by the rainwater exceeding the infiltration capacity of the ground. This is of particular concern in urbanized landscapes, were there is little capacity for the ground to absorb rainfall due to the built environment. The highest standard for surface water drainage in England and Wales is typically 30 years. Drainage and sewage systems were overwhelmed by the extreme summer rainfall totals, which exceeded the 100-year rainfall amounts in many locations. Streets became rivers with water pooling in dips and basins. In some areas, standing water remained for several days.

June 25 Flood Event

By late June, soil moisture and river levels were higher than average due to wet weather conditions during the previous seven weeks, in particular from heavy rain that fell on June 15, and were further tested by the high rainfall amounts that fell on Monday, June 25.

Hull and the neighboring town of East Riding were particularly badly hit by flash floods, as the drainage systems were unable to cope with the extreme levels of rainfall. As the day progressed and the rain and over-land flow fed into the already swollen rivers, the River Aire overflowed in Leeds, flooding just over 100 properties. The city escaped catastrophe by millimeters as the flood waters continued to rise on Monday. The River Don in Sheffield burst its banks, flooding properties, including the many commercial and industrial units that lie along the river. During Monday night, the River Rother, to the south of Sheffield, overtopped its banks, flooding around 100 properties in the flood-prone village of Catcliffe. Flood depths were so high that bungalows were almost completely submerged by the flood water. The flood wave continued, traveling down the River Don and its tributaries from Sheffield through Rotherham toward Doncaster. On Wednesday night the River Don and its tributaries overflowed in and around Doncaster, severely flooding areas in the North of the city. Table 2 lists the number of flooded properties reported in some of the worst affected towns and cities (Figure 4).

In most cases, flood waters quickly receded, except in the cases of Bentley and Toll Bar in Doncaster, where the water was not able to drain away easily, and several hundred properties were submerged for several days. These two areas, along with Catcliffe, featured heavily in the media coverage at the time. In most cases the flooding

Figure 4: Map of northeast England depicting the area most badly affected by the June 25 floods

Region	Number of Flooded Buildings	Flash Flood	Fluvial Flood (River, Date)
Hull	6500	√	
East Riding	5800	√	
Sheffield	1273	√	Don, June 25
Doncaster	5171	√	Don, June 28
Leeds	130	√	Aire, June 25

Table 2: Towns and cities badly affected by the June 25 event

Figure 5: Flooding in Worcestershire during the July floods

was caused by flood defenses being overtopped by the extreme river heights. However, RMS reconnaissance teams also observed breaches of flood defenses in some parts of Sheffield, where parts of stone and brick walls were pushed away by the force of the water.

July 20 Flood Event

In the early hours of Friday, July 20, a deluge of heavy rain fell across central and southern England, triggering pockets of flash flooding across most of England and parts of Wales, including areas such as Barry (in South Wales), Gloucestershire, Lincolnshire, Wiltshire, Hampshire, Surrey, Berkshire, and central London. Many smaller rivers and streams burst their banks in the following hours, leaving homes flooded with up to five feet of water in places. In subsequent days, the rainwater runoff entered the major river system. Due to the heavy rains in June, soil moisture and river levels were higher than average, which exacerbated the extent and severity of the flooding. The flash floods on July 20 were followed by extremely high flows in small responsive catchments such as the Isbourne (Worcestershire) and the Teme and Ock (Oxon). More extensive flooding then followed as runoff concentrated in the major river basins, leading to flooding along the Avon, Severn, and finally the Thames. In some locations, such as Pangbourne and Thatcham in Berkshire and Stratford-upon-Avon, the water took up to three days to drain away.

By Saturday, July 21, much of the water had reached the River Avon in Warwickshire and Worcestershire, flooding towns and villages along its banks to a depth of nearly two meters in places (Figure 5). Exceptional river flows were recorded in Evesham (Worcestershire), where levels on the Avon were the highest ever recorded (based on an incomplete series) since 1848. Widespread flooding occurred along the Severn from Worcester through Tewkesbury to Gloucester. Tewkesbury, located at the convergence of the rivers Avon and Severn, was particularly badly hit — flood waters entered Tewkesbury Abbey for the first time in 247 years. There was also widespread flooding along the River Severn from Upton-on-Severn down toward Gloucester. Because the town's mobile defenses did not arrive in time, severe flooding in Upton-on-Severn was blamed on the Environment Agency (EA). The mobile barriers, a flood defense solution along parts of the rivers Avon and Severn that are deployed when rainfall forecasts and river levels indicate that flooding is imminent, were located over 40 miles away and the vehicles carrying the defenses were caught in traffic due to severe flooding on the roads. The EA claimed that the river levels were so high that the water would have overtopped the barriers in any

Figure 6: Map of central England depicting the area worst affected by the July 20 floods

case. The mobile barriers were successfully deployed in Shrewsbury and Bewdley and were also used to save the Walham electricity switching station, near Gloucester, from inundation. The flood wave peaked in Gloucester on Monday, July 23, and the city center narrowly avoided major flooding.

The flood wave continued to travel along other river catchments, notably the Thames and Great Ouse rivers. The small catchment of the River Ock caused flooding in Abingdon early on Sunday morning. Oxford and neighboring villages were flooded on Wednesday, July 25, as the flood wave traveled down the Thames. Villages and towns farther downstream along the Thames as far as Windsor, including Reading and Pangbourne, were placed on flood alert but escaped flooding when water levels finally peaked on Thursday, July 26. Table 3 lists the number of flooded properties reported in some of the worst affected towns and regions (Figure 6). The EA reported that no defenses were breached during this flood event and that flooding was caused by defense overtopping.

Both of these events not only caused property damage and interruption to business operations, but also affected the country's infrastructure. There was serious disruption to transport during both events, with many roads (most notably the M5 in southwest England) closed due to flooding and landslides on the night of Friday, July 20, leaving travelers stranded. In many cases, roads were badly damaged by the floods and left in need of repairs (Figure 7). Thousands of vehicles were affected by the flooding as roads suddenly turned to rivers. In most cases, vehicles were damaged completely, requiring full replacement, especially if electric systems were affected. Abandoned cars also interfered with transport, as they obstructed many roads. Landslides and flooding blocked many railway lines, closing down some commuter lines for several weeks.

Figure 7: Roads were badly damaged during floods

Region	Number of Flooded Buildings	Flash Flood	Fluvial Flood (River, Date)
Gloucester	1150	√	Severn, July 21
Tewkesbury	1500	√	Severn and Avon, July 21
Cheltenham	1200	√	Chelt, Severn, July 21
Abingdon	100	√	Ock, July 22
West Oxfordshire	1655	√	Thames, July 25

Table 3: Towns and cities most affected by the July 20 event

Disruption to power and water supplies during the July floods was caused by flooding at the Castlemeads power sub-station near Gloucester and at the Mythe water treatment plant in Tewkesbury. At the peak of flooding, around 140,000 households were left without water and 50,000 without power. Fortunately, power supplies were restored within 48 hours, and the first water supplies were turned back on during Thursday, July 25, although the water was not deemed safe for drinking until August 7. Several other power sub-stations were at risk during the peak of the July event in Oxfordshire and Gloucestershire, but were narrowly saved.

The agricultural sector was also badly hit by the floods. Crops were submerged and the National Farmers Union reported that all agricultural sectors had been affected by the summer floods. Crops of peas, carrots, potatoes, and broccoli were lost during the June floods and maize, potatoes, and hay during the July event. It is estimated that around 40% of the pea crop was destroyed by the events. Where floodwater contained sewage, crops had to be destroyed, and to avoid contamination of new crops, restrictions on when future planting can take place will have to be imposed. ■

THE CAUSE OF THE FLOODING

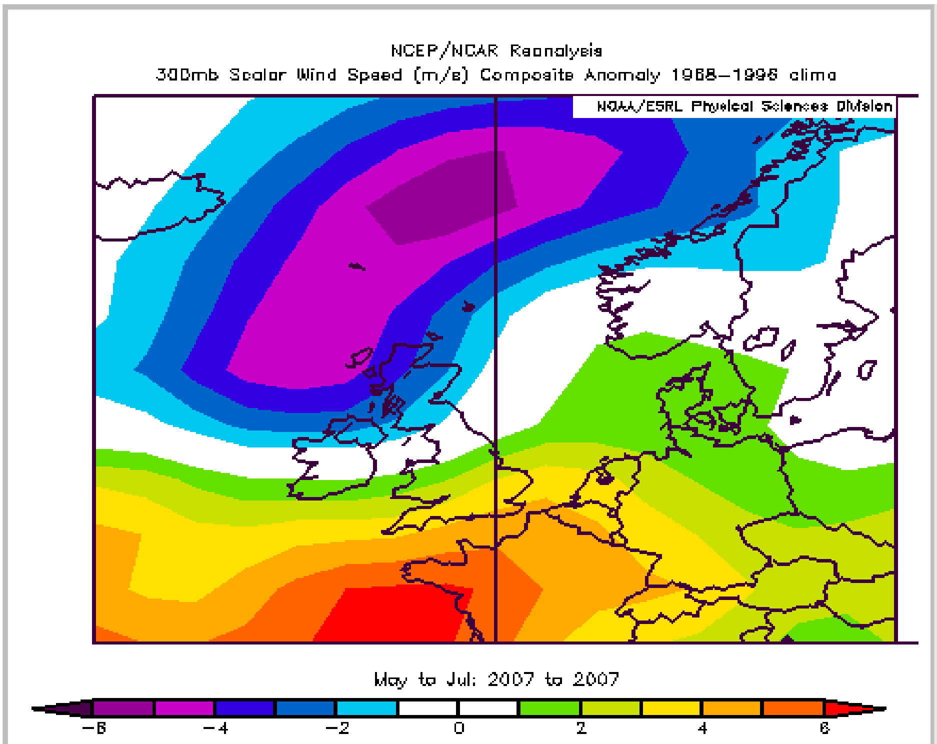
May to July 2007 was the wettest summer in England and Wales since rainfall records began in 1766. U.K. Met Office figures show a three-month rainfall total of 387.6 mm, compared to the 1971–2000 average of 186.3 mm. A steady stream of low pressure systems tracked over the U.K., bringing heavy rainfall to many parts of the country, highlighted by two extreme rainfall events on June 25 and July 20, which resulted in record-breaking June and July rainfall totals. The wet summer also resulted in below average sunshine, reducing evaporation rates, which are usually highest at this time of year. The extreme nature of the rainfall, combined with the low evaporation rates triggered some of the worst summer flooding seen in this country for many years.

The anomalous wet weather of the summer months can be traced back to the large-scale weather pattern that had persisted over the North Atlantic and Europe since early June, driven by the position of the jet stream (Figure 8). Since early June, the jet stream had been located farther south than its normal position, particularly over the eastern Atlantic. There was also a persistent train of waves in the jet stream, from the North Pacific through to Europe, with a trough located close to the U.K. Under these synoptic conditions the Atlantic weather systems were steered toward the U.K. and tended to become slow moving, resulting in more prolonged rainfall than in situations where the weather systems are more mobile. The trough to the West of the U.K. directed air from a more southerly track than normal, passing over warmer sea temperatures, and therefore the air was likely carrying more moisture (Blackburn et al., 2007).

Antecedent Conditions

The meteorological conditions prior to the summer were important contributing factors in the widespread and severe flooding that resulted. Rainfall was above average across England during the winter months of December 2006–February 2007, which increased soil moisture levels and filled up the aquifers (underground layers of rock, sand, or gravel that contain water). Spring followed with close to average rainfall over the U.K. in March, followed by an usually dry April and a very wet May (Figure 9). The above average rainfall in May caused soil moisture levels to increase, leading to higher runoff rates.

Groundwater-fed rivers began a lagged response to the exceptionally wet weather, with the River Lambourn in Berkshire reporting its third highest spring runoff since 1975. Despite river levels being exceptionally low



The jet stream is a relatively narrow, fast flowing current of air, usually located about 11 km high in the Earth's atmosphere. It helps determine the location of high and low air pressure at the Earth's surface and is also responsible for generating and steering weather systems over Europe.

Figure 8: Wind speed anomaly at 200 mb showing the anomalously high band of winds to the south of the U.K. known as the jet stream. Source: NOAA/ESRL Physical Sciences Division, Boulder Colorado (www.cdc.noaa.gov)

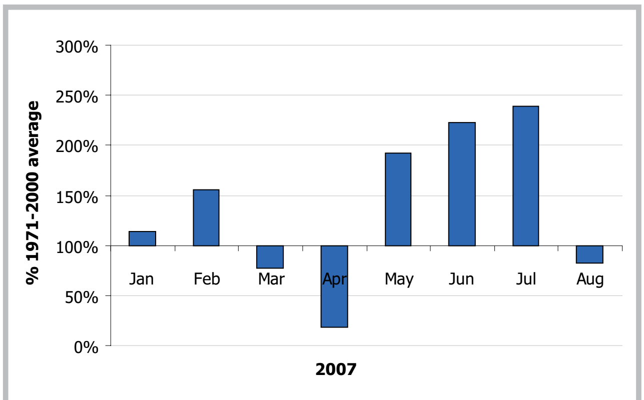


Figure 9: England rainfall anomalies for the months of January to August 2007, based on 1971–2000 average (U.K. Meteorological Office)

at the beginning of May, river flows recovered rapidly from mid May onward, and by the end of the month, the Great Ouse, flowing through Northamptonshire and East Anglia was flowing 'above normal' at 179% of the long-term average. The notably wet conditions in May were key to setting up prime antecedent conditions for flooding during the summer. By the end of May, several flood warnings were in place and the U.K. was vulnerable to flooding from further heavy rain events.

Summer Conditions

Above average rainfall continued into June and July with many intense rainfall events, some record breaking (Figure 9). Given the wet antecedent conditions, numerous flash floods occurred as a response to heavy rainfall events during this period (Table 1). The England and Wales May–July rainfall totals were the wettest on record since 1766. Some of the smaller flash floods would not have occurred if the soil conditions had been more typical for this time of year. Episodes of minor flash flooding continued throughout August as conditions were primed by the extreme wet summer conditions.

June rainfall

East and northeast England recorded the highest June rainfall total since records in this region began in 1914. The month of June was characterized by two exceptional outbreaks of rain on June 15 and 25. A complex low pressure area moved slowly eastward across the country between June 14 and 17, triggering the first significant flooding event, which commenced on Friday, June 15. Heavy rains were triggered over a wide area of the U.K., most notably in the West Midlands and Yorkshire. Many locations were subject to heavy rainfall, with some areas receiving up to 50 mm of rain in just four hours. Rainfall reports from Edgebaston, Birmingham show that 86 mm of rain fell in just 24 hours (between Thursday night and Friday night), compared to a monthly June average of 56 mm at nearby Birmingham Airport.

The second and more extreme rainfall event was associated with a stationary low pressure system centered over Warwick (South of Birmingham) at 06:00 UTC on Monday, June 25, with a central pressure of 995 mb. The low pressure acted to draw in moisture from the North Sea, resulting in heavy and persistent rainfall for much of the day. The rainfall persisted through Monday morning and early afternoon across the northern half of England from The Wash and Humber toward Wales. By 12:00 UTC, the low pressure system had drifted very slightly south, and was centered over Oxford with a central pressure of 993 mb. During the late afternoon and early evening, the low drifted northeast, away from the U.K. Rainfall totals in most affected locations far exceeded their monthly June averages in a 24 hour period (Figure 10) and Fylingdates (North Yorkshire) recorded 103.1 mm rainfall in 24 hours. The Met Office described the rainfall event as a 1-in-100 year event.

By the end of June 25 the Environment Agency (EA) had more than 270 flood alerts in place across England and Wales, more than 15 of which were severe flood warnings defined by the EA as "Severe flooding is expected. There is extreme danger to life and property." Record June maximum flows were established in 12 of the 75 index stations returning high flow data, including some of the major rivers such as the Severn, Trent, and the Dee in North Wales. In South Yorkshire, period-of-record maximum flows were recorded in a number of catchments including the Rother, the Dearne, and the Don, all of which were responsible for flooding in South Yorkshire. A large proportion of the flooding was due to over-land flow, which contributed to the anonymously high June runoff totals that were recorded across the U.K. from Cornwall to northeast Scotland, with many index gauging stations in northeast England and the Midlands establishing new maximum June runoff totals.

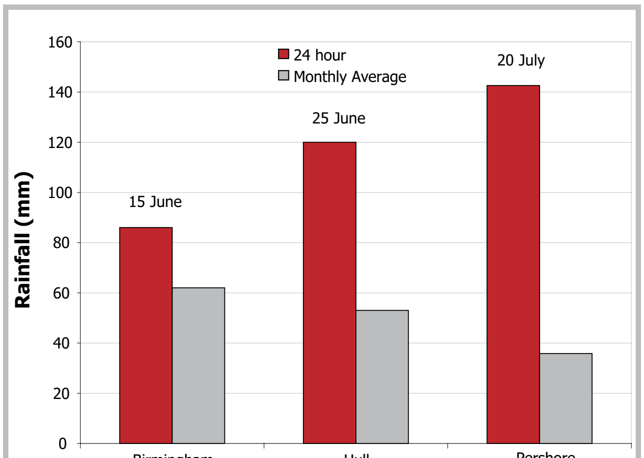


Figure 10: Maximum 24-hour and monthly average rainfall values during the exceptional June and July rainfall events

Figure 11: River Thames in central Oxford, July 27, two days after the peak of the flood wave

With river catchments becoming saturated by the end of June, the flood risk extended into many basins, making many areas extremely vulnerable to further flooding for the following few months.

July rainfall

July was also dominated by cyclonic activity with frequent heavy and prolonged outbreaks of rain, which resulted in the wettest July since 1888. The most notable downpour in July occurred on Friday, July 20, when extremely heavy rain affected parts of south and central England. The rain was a result of a slow moving low pressure system located over Calais, France on Friday morning, which drifted slowly northwest on Friday, July 20, bringing with it a surge of warm continental air to southern and central areas of the U.K. The warm air combined with cooler air to the North, creating a broad area of instability classed as a mesoscale convective complex (MCC).

The highest 24-hour rainfall accumulations were recorded in Pershore, Worcestershire and Brize Norton in Oxfordshire, with 142.6 mm and 126.2 mm recorded, respectively. In Brize Norton, West of Oxford, 101 mm fell within seven hours, three times the July average and the highest daily rainfall since records began in 1968. Most of the Pershore rain fell within 16 hours and was nearly four times the monthly average total. Other locations recorded well above the monthly average in less than 24 hours, with 63 mm recorded in Lyneham, Oxfordshire, (July monthly average of 35 mm) and 40 mm at Heathrow (July monthly average of 45 mm) between 18:00 UTC on Thursday, 19 July and 18:00 UTC on Friday, July 20.

At the height of the flooding the EA had 16 severe flood warnings in place. Around 40% of indexed rivers in England and Wales reported new July maximum flows, and period-of-record maximum flows were recorded in the rivers Teme (Worcesterhire) and Lambourn (Berkshire). The River Avon at Evesham recorded its highest maximum flow since 1848, based on an incomplete time series. In the worst affected areas of the lower parts of the Severn, the Warwickshire Avon basins and some upper reaches of the Thames catchment, flood flows were comparable and may have exceeded those of March 1947. ■

INSURED LOSSES

As of mid-September 2007, the market continues to evaluate the magnitude of the summer 2007 flood losses, and the final outcome may not be confirmed for several months as claims continue to be settled and paid. Based on an analysis of the events at the time, RMS estimated the insured loss for the two main flood events of the summer: £1.25–1.75 billion for the June 25 floods and £1– 1.5 billion for the July 20 events. The loss estimates include property and motor damage and cover business interruption and alternative living expenses as well additional factors that could amplify the losses given the spatial extent and severity of the floods.

At the end of August, the Association of British Insurers (ABI) reported that around 27,000 domestic and 6,800 business claims had been filed for the June floods and an additional 17,500 residential and 7,500 business claims for the July floods. Although the number of residential properties affected by the July floods is lower than the June flood events, average claims are expected to be higher, as the affected properties in the south tend to be of higher value and a greater proportion of the damage will be insured. In Hull, where over 6,000 properties were flooded, the council admitted that their properties were self-insured. For private homes, the penetration of insurance, in particular contents insurance, is likely to be lower than the country average. The ABI reported the average domestic and commercial claims to be £30,000 and £90,000 respectively for the June floods and £40,000 and £90,000 for the July event. The motor industry estimated losses of £25 million from the summer floods, with 4,500 motor claims.

The higher average claims cost is also likely to be driven by the severity of the flooding at each location. Claims analysis research at RMS from previous flooding events shows that costs from flash flooding are typically lower than from fluvial inundation, as the depths and length of the flooding are usually smaller. RMS estimated that flash flooding was the cause for around 70% of the properties damaged during the June 25 floods, a statistic confirmed by the EA. The contribution of flash flooding is expected to be less for the July floods, due to the role of the major rivers such as the Severn and Thames in causing the damage.

Figure 12: Contents damage in Catcliffe from the June 25 event. This sight was common throughout the Sheffield and Doncaster area

In contrast to domestic claims, the total insured cost for commercial properties in the July floods is likely to be lower than for the June flood, as the businesses impacted were generally smaller. There was significant damage to large commercial and industrial units along the River Don in Sheffield during the June 25 event, and as a result, large business interruption losses are expected. Many of the shops on the ground floor level of the Meadowhall shopping center in Sheffield are still closed nearly three months after the flooding. In response to this concentration of damage, the local government set up a program in some areas to help small and medium-sized companies develop recovery plans so they can return to business as soon as possible, which should act to constrain business interruption costs. Overall, therefore, for the June event, commercial losses will be a big driver, whereas residential losses will play a much bigger role in the July event losses.

Contents losses will vary between areas affected by the sudden flash floods compared to properties affected by fluvial flooding. Many properties at risk from fluvial flood risk received warnings directly from the EA, or indirectly through the media, in some cases as much as three or four days in advance. During RMS reconnaissance visits, the teams confirmed that many homes and businesses had responded to the warnings and had mitigated the flood risk by raising contents or lifting them to high floors to avoid damage. This was particularly evident in the July floods, where flood warnings were issued several days in advance along the Thames. Lessons had been learned from the June floods and people took flood warnings more seriously. However, for areas affected by flash flooding, residents were frequently taken by surprise and were unable to secure possessions or movable property.

In addition to the direct damage to property, RMS has identified several elements from these events that will amplify losses due to the extent and severity of the floods, i.e., post event loss amplification. A big factor pushing up residential and commercial property repair costs will be additional cleaning costs from sewage contamination and the inflated prices for goods and services in short supply, known as demand surge. A shortage of drying equipment across Europe caused delays to repairs during the June floods, which subsequently impacted the July floods weeks later. In addition to this, the situation in Gloucestershire from the July floods was exacerbated due to power and water cuts, which hindered recovery efforts.

A further issue that RMS expects to be a factor influencing the total payout for the summer 2007 floods is 'coverage expansion,' whereby insurers may need to pay out more than is covered in the issued policies. For example, after major disasters insurers often end up meeting the total costs of people having to relocate, or paying the full amount to replace contents that may have been undervalued when a policy was taken out. ■

EVENT IN PERSPECTIVE

Hazard Perspective

While it is not usual to have extreme rainfall and flooding in the summer months, the frequency and spatial extent of the summer rainfall has been extremely unusual. Many rainfall records have been broken this summer — it has been the wettest summer in England and Wales since 1766, when records began and record daily rainfall totals have been recorded at many weather stations. Groundwater levels generally decline over the May to September period due to an absence of natural replenishment (recharge), and examples of significant and widespread summer recharge in the 20th century are very rare. However this summer, groundwater levels in the Cotswolds were above the normal winter levels by the end of July.

There are several historical examples of extensive summer floods affecting the U.K. (e.g., in 1875), particularly in the nineteenth century when summer half-year (May–October) rainfall often exceeded that of the winter half-year. There have been severe flood events in the last century from similar meteorological conditions as those observed this summer. Stationary East Coast lows, such as the June 25 rainfall event, have occurred in the past, causing widespread flooding. The August 1912 East Coast rainfall event caused severe flooding along the East Coast of the U.K., resulting in notable flood damage to Norwich. Similarly, there have been other severe mesoscale convective complex (MCC) systems which have caused flooding, such as the 1952 Lynmouth floods, where 228 mm of rain fell within 12 hours over the southwest tip of England. However, the July 2007 MMC event eclipsed this event in its spatial extent and severity.

Figure 13: Flood height measurements outside a bicycle shop in Evesham, Worcestershire

Although these severe rainfall events are therefore not unprecedented, the combination of two extreme events in the space of five weeks is highly unusual. The result was that peak river flows in central England catchments exceeded previous recorded maximums and summer flows were redefined over large areas. In many cases, river flows greatly exceeded the 100-year flows and broke monthly flow records in many catchments. During the June events, period-of-record maximum flows were recorded in a number of catchments in Yorkshire and the same was observed in July for catchments for Warwickshire, Worcestershire, and Berkshire. The outstanding wet summer soils have allowed substantial aquifer recharge in some areas, a very rare circumstance in the context of the last 100 years.

Are the extreme rainfall events a product of climate change?

The drivers for the extreme U.K. summer 2007 rainfall events were the position of the jet stream, the warm moist air, and the fact that the storms have been relatively slow to move away. It is currently not possible to say that any single weather event can be directly attributed to climate change. Conclusions from the Intergovernmental Panel on Climate Change (IPCC) 2007 report suggest that in the U.K., over the time horizon of the next thirty years onward, extreme rainfall is likely to increase in the winter — predictions for the summer, however, are mixed. There is currently a great deal of uncertainty in the scientific literature around the likely changes in summertime precipitation, as extreme rainfall events may increase due to enhanced rainfall from isolated convective storms in a warmer atmosphere with more moisture, or conversely may decrease, due to a decreased number of precipitation days in the summer. Improved modeling and understanding of how to attribute single events to climate change versus natural climate variability will, in the future, help to reduce this uncertainty for the U.K.

A final, important point is that increased extreme rainfall does not automatically lead to increased flooding. For instance, if summers become drier, leading to increased soil moisture deficits, this is likely to offset the increased extreme precipitation to some extent, as the soil will have greater capacity to soak up excess rainfall.

Does the abnormal rainfall this summer increase the risk of flooding this winter?

There are two factors that will determine flood risk over the coming winter — firstly, the antecedent conditions, and secondly, the actual weather patterns and amount of rain we will receive. The exceptionally wet summer has led to a reduced soil moisture deficit — meaning a reduced capacity to absorb rainfall. There is limited time now for the deficit to re-establish as the growth season ends and evaporation rates decrease with declining temperatures and reduced solar radiation. High groundwater levels and saturated soils will likely lead to the early onset of the winter recharge season, and if a wet autumn and winter were to occur, water tables could reach exceptionally high levels, leading to enhanced flood risk. Given the extreme hydrological conditions, slightly above average rainfall this autumn and winter could be enough to trigger further flooding, and from this perspective there is a higher risk of flooding over the next months and into 2008 in central and northeast England.

Weather patterns are far more difficult to predict. At the start of September, U.K. Met Office seasonal forecasts are predicting average or below average rainfall during the autumn months and average rainfall during

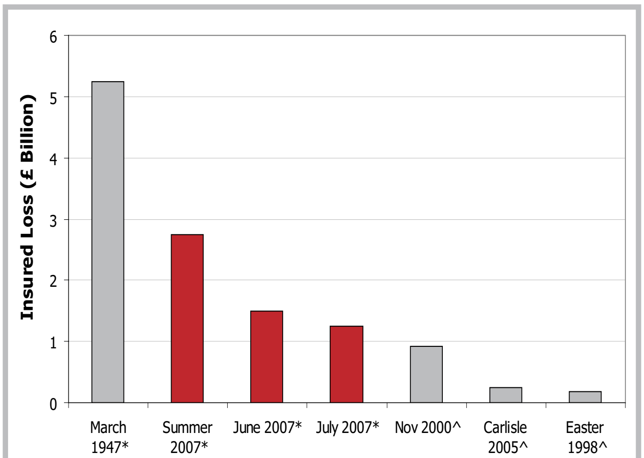


Figure 14: Recent historical U.K. insured flood losses (est. 2007) compared to the loss if the 1947 flood event were to occur again today.
** RMS loss estimate, ^ ABI loss estimate.*

winter. The North Atlantic Oscillation (NAO), which has a strong influence on U.K. winter weather, is predicted to be in a very weak negative phase this winter (forecasted index value: -0.34). Negative NAO phases typically bring colder and drier winters to the U.K. If this forecast bears out and there are no intense rainfall events, the U.K. might narrowly escape further severe flood events in the coming weeks and months.

Market Perspective

The estimated insured losses from these summer events are the largest flood losses in insurance history for the U.K. (Figure 14) and the largest U.K. natural catastrophe since the destructive Windstorm Daria in 1990, which would cause around £4 billion in losses today. According to the Chartered Institute of Loss Adjusters (CILA), claims received in the two weeks following the June floods were equivalent to two years of normal storm and flood numbers. The summer floods follow on from Windstorm Kyrill at the start of the year, which is estimated to have caused around £600 million in insured losses, making 2007 one of the most expensive years for U.K. insurers since Daria in 1990.

The two catastrophic flood events each exceed the November 2000 floods, which caused around £750 million in flood losses at the time and were the largest insured flood losses in the U.K. until this year. However, the individual and combined flood losses from this summer do not exceed the losses from the devastating March 1947 floods, if the event were to occur again today. Earlier this year, RMS released the report *1947 U.K. River Floods: 60-year Retrospective* (available on www.rms.com). RMS estimated that if the event were to occur again in 2007 under today's defense standards that insured losses would be around £4.5–£6 billion. The 2007 and 1947 flood events are very different. The 1947 floods were not caused by extreme rainfall but by snow-melt in combination with heavy rainfall and impacted a much larger area. However, antecedent conditions played a role in both events. This summer, the wet weather and reduced evaporation rates which began in May saturated catchments in England and Wales and increased water levels. In 1947, the frozen hard ground from the severe winter was unable to soak up the snow melt and precipitation leading to high levels of water runoff.

According to the Association of British Insurers (ABI), there are more than two million homes at risk from coastal or inland flooding, and around 400,000 homes at very high risk of flooding (greater than 1.3% or 1-in-75 annual probability as more and more homes are built on the floodplain). Insurance coverage in the

U.K. is globally unusual in that flood cover is typically included as standard within property insurance policies and members of the ABI are committed to continuing the provision of cover as long as sustained and sufficient investment in flood defenses continues. This has been brought into question by floods such as the autumn 2000 events and the Carlisle flooding in 2005 and has been highlighted further by the catastrophic summer floods. Over the last few years, the ABI has called for the government to increase spending on risk management and flood defenses to ensure that they can continue to provide insurance and have proposed the government to increase spending to £750 million per year by 2010. On July 3rd, the Environment Secretary, Hilary Benn, announced that the government would increase spending by £200 million to reach £800 million by 2010–2011. The ABI lauded this promise but added that the increase should come three years earlier in 2008–2009.

The issue was enhanced further by the release of the new Government Housing Green Paper in July which commits the U.K. government to building three million homes by 2010. Within this paper, the government said it was unrealistic to rule out building within the floodplain but reported that strict measures would be put in place to ensure that no development is planned on land classified as high flood risk by the EA. Planning regulations have recently been tightened to make consultation with the EA a requirement, rather than a recommendation as previously (PPG25 in 2001 was replaced with Planning Policy Statement (PPS) 25 introduced in December 2006 by Communities and Local Government). However, the continuing demands for new housing, commercial premises and high-value projects in the Southeast will continue to put pressure on floodplains for development. The most notable example of this is the Thames Gateway regeneration project through eastern London and beyond. The ABI responded to the Government Housing Green Paper by stating that new housing developments must be built away from flood-prone areas and designed with flooding in mind to ensure that flood insurance continues to remain widely available and competitively priced.

Some insurers have already increased their property rates in response to the floods this summer. At the time of this report, the insurance and reinsurance markets are still evaluating the final costs of the summer floods, and thus the full impact is yet to be realized. Within the reinsurance market, there are suggestions that the hours clause definition may be redefined and extended beyond the traditional 168 hours commonly used in the U.K. What is clear is that these events will significantly focus the market on their flood exposure accumulation management and the importance to understand the flood risk both on and off the floodplain. The flood events this summer have highlighted the flood risk outside the floodplain and the importance to understand and assess the risk from all sources of flooding and the potential correlation of flood risk. Flood zone maps, while useful for underwriting and assessing single location flood risk, have limited use for portfolio management. Fully probabilistic flood risk models capturing all sources of flood risk provide the most accurate way to assess and manage portfolio flood risk. RMS remains committed to providing sophisticated tools for the industry to price and manage their flood risk accumulations, having provided a fully probabilistic flood model for the U.K. covering both on and off floodplain sources of loss since 2002. ■

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