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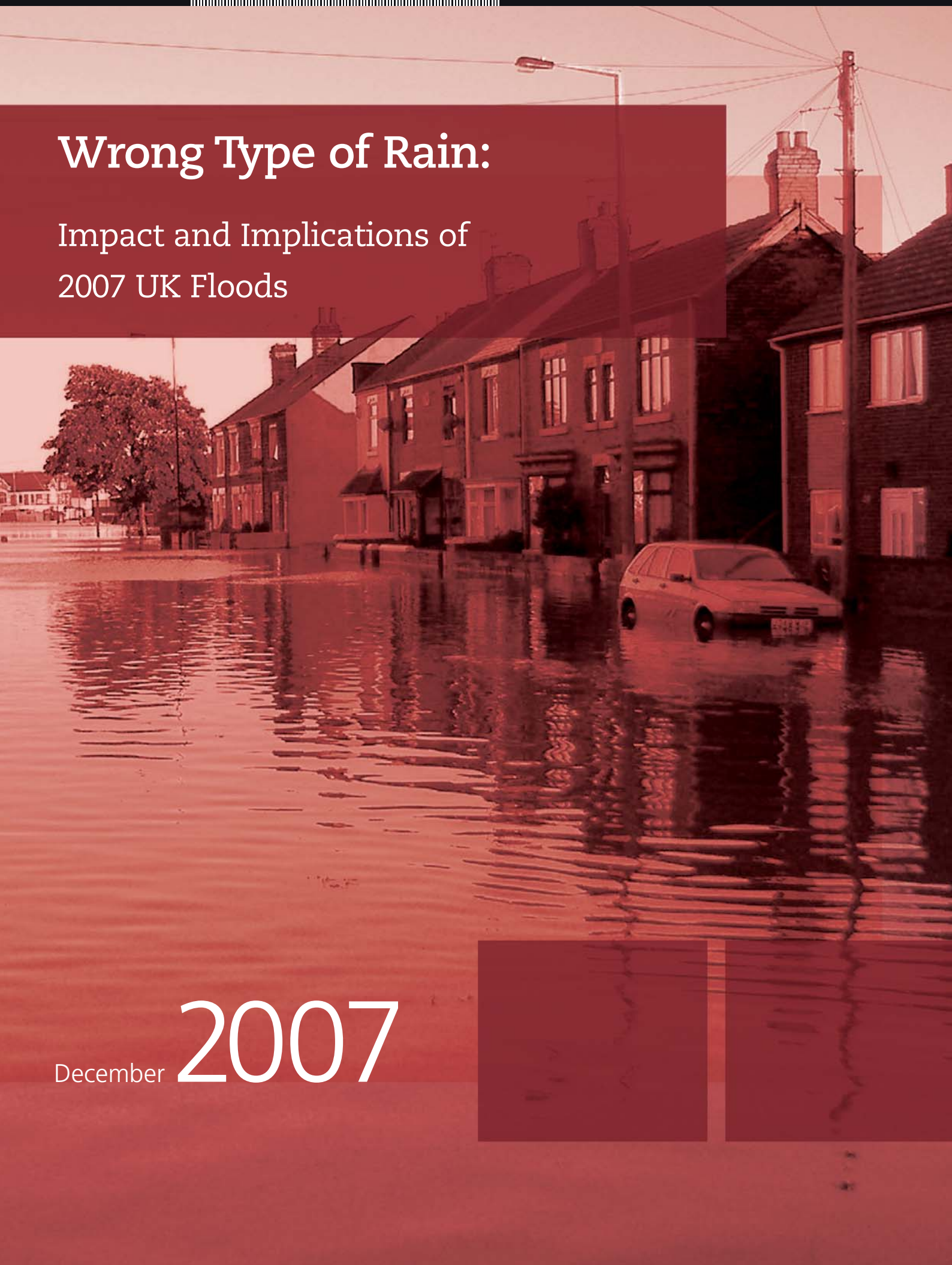
Wrong Type of Rain:

Impact and Implications of 2007 UK Floods



December 2007

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Executive Overview

The summer of 2007 was the wettest in England and Wales since records began in 1914. Extensive pluvial and fluvial flooding in north-eastern England in June and central and south-western England in July caused extensive and severe damage. More than 130,000 insurance claims were submitted and the cost of insured losses is estimated at over £3bn (US$6.2bn).

Guy Carpenter provided exposed value estimates to insurers after the flood events using its post-event analysis service, RealCat^{iX} [1]. Event extents were determined using input from satellite data and ground-surveying information, and the insured exposure per portfolio was calculated using Guy Carpenter's in-house modelling platform, G-CAT™.

The cost of flood damage was largely borne by the UK insurance industry. A relatively small proportion of the losses were ceded to reinsurers due to the steady rise in attachment points on UK and pan-European catastrophe programmes and the effect of hours clauses that classified the June and July floods as separate events.

The impact of the flood losses on reinsurance pricing is not expected to be significant. More sideways cover may be purchased to absorb the increased frequency arising from higher retentions. In addition, interest in catastrophe bonds and other capital market solutions, such as index-linked products, to mitigate higher severity is expected to increase.

The overtopping of riverbank defences due to the large volume of water during the floods exposed the inability of the UK's flood defences to cope with the largest flood events. The issue rose high up the political agenda with the Association of British Insurers (ABI) criticising the UK government. The ABI argued that the planned increase in annual spending on flood defences of £800m (US$1.6bn) a year is insufficient if insurers are to continue to provide cover as widely as possible. The issue was further highlighted when the government announced plans to build three million new homes by 2020, some of them on known floodplains where 'proper defences' are in place. This is in addition to the two million homes already at risk from coastal and fluvial flooding.

The 2007 floods, whilst large, were not unprecedented. The past 200 years have seen events that were more extensive, and floods on a similar scale to these would cause larger losses today. The UK also faces a serious risk of sea surge flooding. Many climate models predict that the frequency of severe floods in the UK will increase but it is not possible to predict the potential effects of climate change based on the events of a single year. Furthermore, rising property values and increased development on floodplains may have an even greater effect on insurers' exposures in the next few years.

1 *RealCat^{iX} is part of Guy Carpenter's i-aXs™ toolsuite. i-aXs is a web-based risk management platform that enables Guy Carpenter clients to instantly access and analyse data and make quicker business decisions about risk. Please go to http://www.i-axs.info for more details.*

Section 1

Overview of Flood Damage in England and Wales in June and July 2007

Major observations from section one:

- The Met Office said the summer of 2007 was the wettest in England and Wales since records began in 1914.
- The wet weather was caused in the main by the position of the jet stream, which plays an important role in both generating and steering weather systems across the United Kingdom.
- Yorkshire and the city of Hull were badly affected by the floods in June with thousands of properties inundated.
- The July floods devastated towns and cities in Gloucestershire, Oxfordshire, Worcestershire, Warwickshire, Herefordshire, Lincolnshire, Bedfordshire and Berkshire.
- Following the floods, more than 130,000 insurance claims were filed at an estimated cost of £3bn (US$6.2bn), making the event the second largest ever insured loss for natural disasters in the UK and the largest ever flood-related loss.

Introduction

Parts of the United Kingdom suffered their worst flooding in 60 years during the summer of 2007 with south-west England, the Midlands, Yorkshire and the city of Hull left under water. The Met Office said the summer was the wettest in England and Wales since records began in 1914 as a series of fronts moved across both countries, triggering severe and widespread flooding. Two severe flood events within four weeks of one another accounted for the bulk of the damage, with mainly pluvial flooding hitting north-east England in June and significant fluvial flooding inundating central and southern parts of England in July.

Together, these events combined to cause the largest flood loss ever in the UK as more than 130,000 claims were filed at an estimated cost of £3bn (US$6.2bn). The 2007 floods surpassed the previous largest insured flood loss that occurred in November 2000 and provisionally ranks as the second biggest ever loss in the UK.

Meteorological Summary

The floods in 2007 were caused by wet and unstable weather that triggered heavy rainfall and flooding. Unusually heavy rain fell in the UK as early as May, creating high soil moisture content, and continued throughout the summer. Rainfall figures produced by the Met Office show that 362.1 mm (14 inches) of rain fell in the UK between 1 June and 31 August, exceeding the previous record of 358.4 mm in 1956 (see Table 1). All parts of the country had above-average rainfall, with the Midlands and north-east England receiving nearly double their regional averages (see Figure 1) while several other parts of England saw records tumble. This increased soil moisture caused runoff as little precipitation was absorbed. The heavy rainfall was also compounded by low evaporation rates due to below-average sunshine.

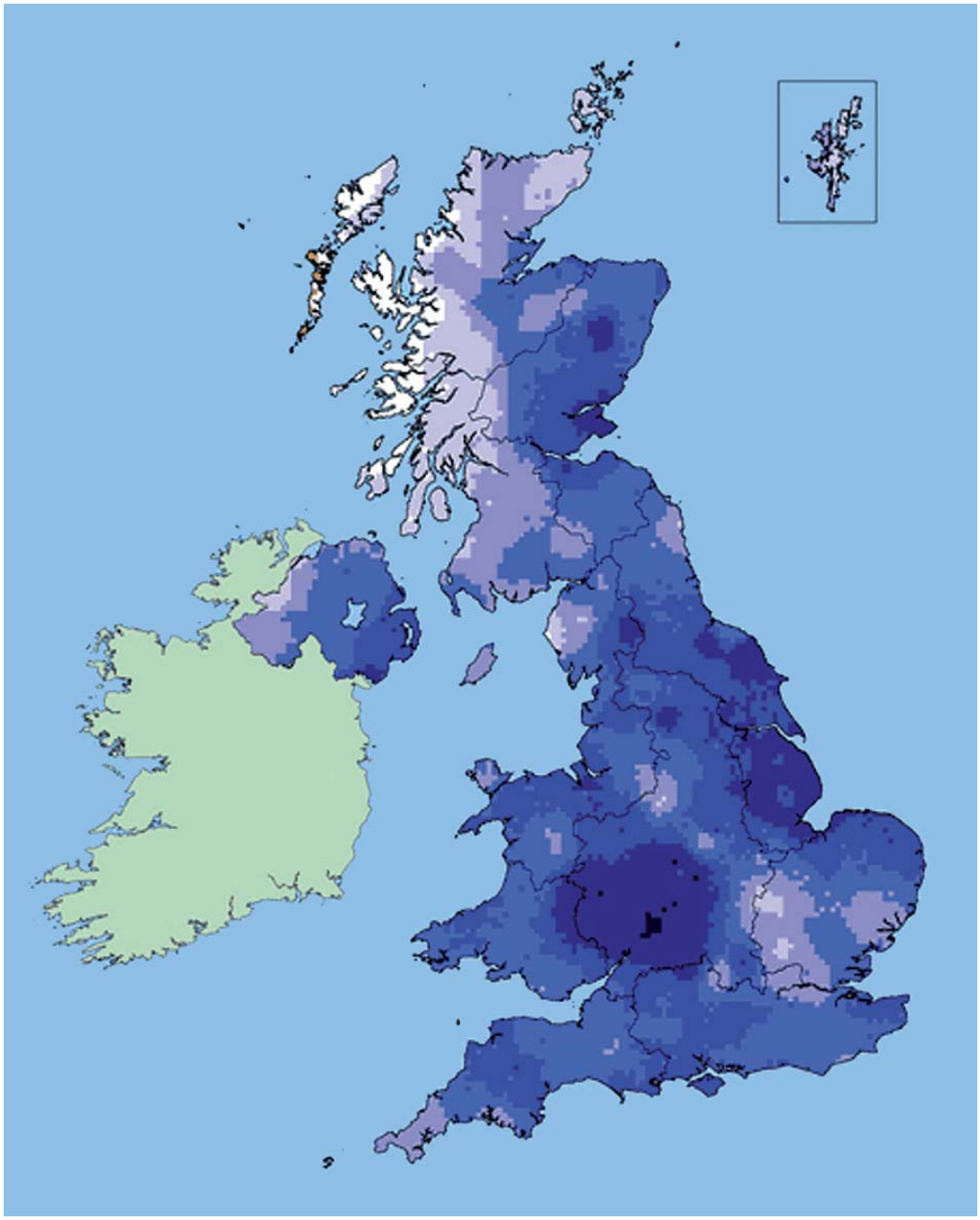
TABLE 1: TOP FIVE WETTEST SUMMERS IN THE UNITED KINGDOM

Source: Met Office

Rank	Year	Rainfall amount between 1 June and 31 August (mm)
1	2007	362.1
2	1956	358.4
3	1985	342.7
4	1927	336.3
5	1931	327.0

FIGURE 1: ANOMALY OF RAINFALL BETWEEN 1 JUNE AND 28 AUGUST 2007 AGAINST THE LONG-TERM AVERAGE IN THE UK

Source: Met Office © Crown copyright 2007



The wet weather was caused in the main by the position of the jet stream, a fast and narrow flow of air usually located about 11 km (7 miles) high in the earth's atmosphere. The jet stream plays an important role in both generating and steering weather systems across the UK, and for much of the summer it was stronger and located further south than normal. The location of the jet stream is closely related to the polar front, where warm tropical air meets cold polar air. The changes in temperature and moisture content across this boundary are greatest at the surface and they decrease higher up in the atmosphere. In addition, mid-latitude storms that move from west to east are more likely to form if the polar front is more pronounced.

Due to seasonal variations in the amount of solar energy received in the Northern Hemisphere, the polar front and the jet stream normally shift with the sun, moving north in spring and south in autumn. Yet, for most of the summer of 2007, the jet stream was not only stronger than usual (increasing the probability of storm formation), but it also did not move as far north as expected. The jet stream's more southerly location was especially pronounced in the eastern Atlantic, leading to a persistent train of waves from the north Pacific through to Europe. Due to a trough close to the UK, the weather systems were not only steered towards to the country, but they carried more moisture than usual and moved more slowly over England and Wales, resulting in intense and prolonged rainfall.

These depressions brought very heavy rainfall in June and July in particular, causing pluvial floods in June because drainage systems were unable to cope. Latterly, as the soils became saturated from the persistent and heavy rainfall, swollen rivers burst their banks and caused significant flooding in central and southern England.

Event Summary of June Floods

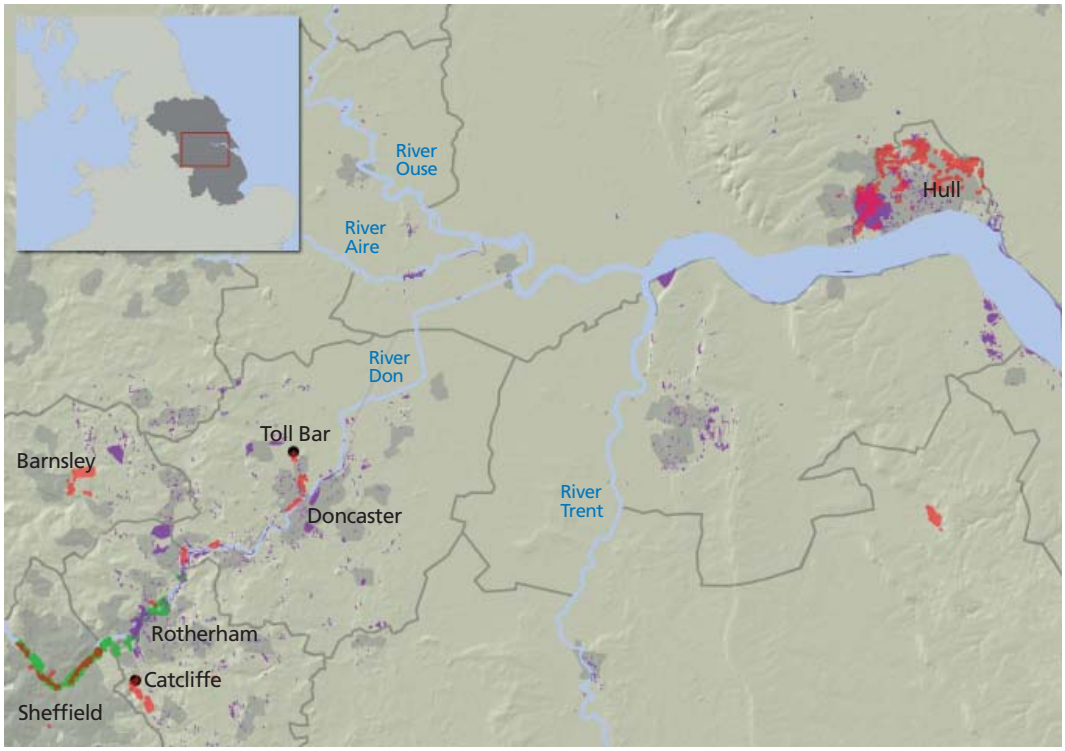
Heavy rainfall began on 25 June because of a stationary low pressure that drew in moisture from the North Sea, resulting in heavy and persistent rain that extended from Yorkshire and Humberside to Wales and down to the south-west of England. The rain that fell during the week of 25 June broke daily records in many affected areas and a month's worth of rain fell within 24 hours in several locations. The Environment Agency (EA) said that up to 100 mm (4 inches) of rain fell in 24 hours in the worst-affected areas (103 mm in Fylingdales and 100 mm in Hull), well over a month's average rainfall for June.

At the height of the flooding on 26 June, the EA had 27 severe flood warnings in place (the majority of which were located in the hard-hit north-east of England) and over 100 flood warnings. The EA said that the flooding mostly resulted "from surface water drainage and defences being overtopped by the sheer amount of water – which has been more than a 1-in-150 year event in many places". The UK Met Office described the event as a 1-in-100 year event. The heavy rainfall also caused several rivers (including the Don, the Dearne and the Idle in Yorkshire) to burst their banks. However, according to the EA, five times as many homes and businesses were flooded by drainage overflows than by fluvial flooding. Tree debris being carried down rivers and causing partial blockages at bridges also contributed to the overtopping of defences and river banks.

The flooding came as England experienced its wettest June since 1914. The Met Office said England received 140.2 mm (5.5 inches) of rain during the month, which was considerably higher than the UK average of 72.6 mm and beat the previous June record of 121.2 mm in 1980. The event was compounded particularly by heavy rainfall that fell in northern and central regions on 14 and 15 June and created wet soil conditions and raised river levels.

FIGURE 2: AREAS OF ENGLAND HIT BY THE FLOODS IN LATE JUNE

- Urban Areas
- Affected Towns
- Affected Postcodes (Identified by RMS)
- Affected Sheffield Postcodes (Identified by JBA)
- Flooded Areas (Identified from Aerial Photographs by RealCat)



Damage from the late June floods was widespread and reports said that the city of Hull, Yorkshire, Lincolnshire and the Midlands were the worst-affected areas, with power cut to tens of thousands of households. Counties in south-west England, including Devon and Gloucestershire, and north-west Wales were also affected. Five people were killed. Crops across England were devastated and transport links were badly disrupted, with roads closed and train services delayed or cancelled. The flooding caused structural damage to pavement construction and ponding on railway tracks, which prevented their use until the waters had subsided.

Yorkshire

Yorkshire was severely hit by the floods and emergency services said that they received 1,800 calls on 25 and 26 June alone. Sheffield, East Riding, Rotherham, Barnsley and Doncaster were flooded and thousands of people were forced to evacuate their homes. Sheffield reportedly experienced its worst flooding on record, caused by a combination of fluvial and pluvial floods. Two people were killed and commercial and industrial properties were severely hit. Advance flood warnings were issued to the local population but the volume of water exceeded expectations and flooding occurred to a significant area.

The River Don, which flows through the centre of Sheffield, burst its banks and severely flooded parts of the city centre. The depth of flooding inside both commercial and domestic properties was reported as reaching approximately 2 m (6.5 feet) but, more typically, the depth was around 1 m (3 feet). According to council officials in the city, more than 1,250 properties were affected in the Sheffield area and hundreds of people were trapped in homes and business premises.

FIGURE 3: FLOODED STREETS IN SHEFFIELD

Source: JBA Consulting

Damage to domestic properties was predominantly confined to soft furnishings like carpets, furniture and curtains but there was also some damage to other fixtures and fittings, particularly kitchen cupboards, central heating boilers and fires. The effect on commercial premises in Sheffield was also significant. Shops on the ground floor of the Meadowhall shopping centre were flooded and the entire centre was forced to close for a week. There were also reports of damage suffered by other industrial and commercial operations in Sheffield. This tended to come from water flowing through the buildings rather than from walls collapsing but there was significant damage to stock that had been stored on the floor in areas that became flooded. Several businesses in the area were also forced to close temporarily, which led to substantial business interruption claims.

The nearby town of Rotherham was also flooded and placed on alert after cracks appeared in the Ulley Dam. There was significant flooding in the town's centre and hundreds of residents had to be evacuated as a precaution due to the risk of the dam bursting. However, engineers managed to reinforce the dam wall. Despite this, around 1,000 properties were flooded in the Rotherham area, with the village of Catcliffe particularly badly hit after the River Rother burst its banks.

Elsewhere in Yorkshire, Wakefield and East Riding each had around 2,000 homes flooded. The situation was similar in other parts of the county. In Doncaster, for example, the River Idle burst its banks, flooding around 1,500 properties and forcing hundreds of people to evacuate their homes. Toll Bar in the Doncaster area suffered badly, with 95% of the village affected and floodwaters over a metre high seven days after the initial flood in some places. Emergency services had to use inflatable boats to rescue people trapped in their homes. In Barnsley, around 550 houses were flooded. The council described the floods as the "worst natural disaster in living memory".

FIGURE 4: AROUND 1,500 PROPERTIES WERE FLOODED IN DONCASTER

Source: IPR/95-10C BGS © NERC 2007. All rights reserved

FIGURE 5: TOLL BAR WAS ONE OF THE WORST-AFFECTED AREAS WITH ENTIRE COMMUNITIES EVACUATED TO SAFETY

Source: JBA Consulting

FIGURE 6: THOUSANDS OF HOUSES AND BUSINESSES IN THE CITY OF HULL WERE FLOODED

Source: IPR/95-10C BGS © NERC 2007. All rights reserved

Humberside
The Humberside fire and rescue service received thousands of calls, as households were flooded in the county. The city of Hull suffered by far the most damage in Humberside after around 100 mm (4 inches) of rain fell within a few hours, triggering severe pluvial flooding. According to Hull's council, the flooding inundated around 6,500 properties across the city after the drainage system was unable to cope with the unexpected quantity of water.

Up to 35,000 people were affected by the flooding in Hull, with around 10,000 homes evacuated and 95% of schools damaged. Hull City Council estimates it could cost more than £200m (US$407m) to repair the infrastructure damage alone. Reports also said businesses in the city were affected and several golf courses, leisure centres, the race course and theatres were forced to close.

Lincolnshire
The towns of Louth and Horncastle were the worst-affected areas in Lincolnshire. More than 100 homes and businesses were flooded, and many more lost power. Flooding was also reported in Lincoln and Grantham.

Midlands
Reports suggest that the flooding and damage in the Midlands following the heavy rainfall was not as severe as in Yorkshire and Hull. Although the levels of the River Trent rose, it did not overflow and the flooding in the region appears to have been mainly caused by surface runoff. Consequently, several villages in Nottinghamshire were affected by pluvial flooding, including Lowdham where around 300 homes were flooded. Elsewhere, properties in Lambley, Woodborough and Burton Joyce were also affected.

FIGURE 7: THE FLOODING SPREAD AS FAR SOUTH AS NOTTINGHAMSHIRE, INUNDATING HUNDREDS OF HOMES

Source: IPR/95-10C BGS © NERC 2007. All rights reserved

The heavy rainfall throughout the UK in the early summer, and in June particularly, created wet soil conditions and raised river levels that left many areas vulnerable to further flooding for the remainder of the summer.

Event Summary of July Floods

Just over three weeks after the floods in June, another slow-moving low-pressure system dumped more heavy rain on parts of central, western and southern England, swelling already high river levels and triggering more floods. At least five people were killed by the floods that started on 20 July. Extensive flooding occurred in major river basins in July, leading to defence overtopping along the Avon, Severn and Thames rivers and their tributaries. At their highest, some rivers were more than 6 m (20 feet) higher than normal and the water levels in some areas along the Severn and Thames exceeded those of the devastating floods of 1947, according to the EA. Reports said that the floods prompted the largest peacetime airlift rescue operation in the UK as tens of thousands of people were stranded. Several towns and villages were flooded as more than a month's rain fell in just a few hours in some areas and thousands of vehicles were badly damaged.

FIGURE 8: FLOODED LAND IN THE SEVERN FLOODPLAIN IN GLOUCESTER

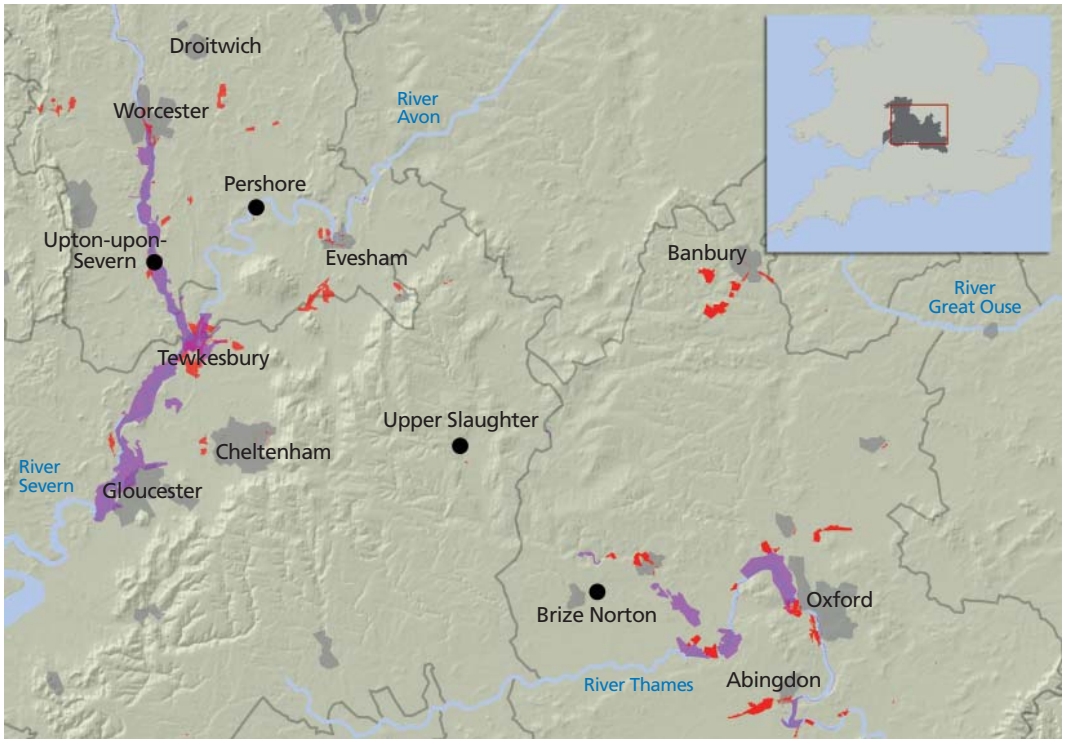
Source: IPR/95-10C BGS © NERC 2007. All rights reserved

The EA described the rainfall as "very extreme" and MeteoGroup UK, a weather forecaster, said the towns of Pershore in Worcestershire and Brize Norton in Oxfordshire were worst hit, with 145.4 mm (6 inches) and 126.2 mm (5 inches) of rain falling in 24 hours respectively, around two months' worth of precipitation. The severe weather was caused by a slow-moving low-pressure system that created a broad area of instability with intense rainfall. At the height of the flooding on 21 July, the EA had 16 severe flood warnings in place, the majority of which were in the Midlands area.

The floods devastated towns and cities in Gloucestershire, Oxfordshire, Worcestershire, Warwickshire, Herefordshire, Lincolnshire, Bedfordshire and Berkshire. The government estimated that thousands of properties in these counties were inundated. Residents in the region were forced to evacuate their homes as parts of the Severn, Avon and Thames rivers burst their banks.

FIGURE 9: AREAS OF CENTRAL AND SOUTHERN ENGLAND HIT BY THE FLOODS IN JULY

- Urban Areas
- Affected Towns
- Affected Postcodes (Identified by RMS)
- Flooded Areas (Identified from Aerial Photographs by RealCat)



Gloucestershire

The floods caused severe and extensive property damage across central, western and southern England. Gloucestershire was one of the worst-hit counties. Tewkesbury, which lies at the point where the rivers Avon and Severn join, was completely cut off and under water while Cheltenham, Badgeworth, Upper Slaughter, Stroud and the city of Gloucester also experienced severe flooding.

FIGURE 10: SEVERE FLOODING AT TEWKESBURY

Source: IPR/95-10C BGS © NERC 2007. All rights reserved

Reports said water levels in the Severn at Gloucester peaked at 50 mm (2 inches) below the flood defence wall, marginally preventing the city centre from being submerged and the Walham substation, which provides power to 250,000 properties, from being flooded. However, the Mythe treatment plant in Tewkesbury was flooded, leaving 350,000 homes without running water for more than 10 days. Severn Trent Water finally restored the water supply to all affected homes by 2 August.

FIGURE 11: FLOODING AT THE MYTHE TREATMENT PLANT CUT WATER SUPPLIES TO HUNDREDS OF THOUSANDS OF HOMES

Source: IPR/95-10C BGS © NERC 2007. All rights reserved

Midlands
Parts of Worcestershire were submerged by 1.82 m (6 feet) of water as the Severn burst its banks. Towns and villages flooded included Evesham, Worcester, Tenbury Wells, Bewdley, Stourport-on-Severn, Upton-upon-Severn, Droitwich, Pershore, Honeybourne and Sedgeberrow.

Warwickshire was also badly affected by the flooding. The floods in Warwickshire were mainly caused by five rivers (Leam, Avon, Tame, Alne and Sowe) bursting their banks and inundating several towns in the county, including Stratford-upon-Avon and Coventry.

Oxfordshire and Berkshire
The floods travelled down to other river catchments, causing the Thames and some of its tributaries to overflow in Oxfordshire and Berkshire. More than 1,000 homes were flooded in both counties, including 550 properties in the badly hit town of Abingdon after the River Ock burst its banks. Widespread flooding was also reported in Banbury. Towns and villages further downstream of the Thames, including Reading, were placed on flood alert but no serious damage was reported.

FIGURE 12: HUNDREDS OF HOMES WERE FLOODED IN ABINGDON

Source: IPR/95-10C BGS © NERC 2007. All rights reserved

Lincolnshire
Parts of Lincolnshire were flooded for the second time in a month, with properties in Horncastle, Louth and other villages inundated.

Infrastructure and Agriculture
Considerable damage was also caused to infrastructure in the affected areas while the agriculture sector suffered severe losses. The National Farmers' Union said all agricultural sectors were affected by the floods and the bill for lost or damaged crops, livestock and milk sales was expected to run "into the billions of pounds". Local infrastructure, meanwhile, was devastated as there was severe disruption to power and water supplies across the affected region, giving potential to significant business interruption claims, while hundreds of roads were damaged and made impassable.

Insured Losses

The Association of British Insurers (ABI) expects the floods in June and July to cost insurance companies around £1.5bn (US$3.1bn) each, giving a total loss of £3bn (US$6.2bn) for both events. This would make the 2007 floods the second largest ever insured loss for natural disasters in the UK and the largest ever flood-related loss (see Tables 2 and 3).

A total of 130,000 claims have been made, with 100,000 from householders (45,000 major and 55,000 minor), 20,000 related to commercial property (15,000 major and 5,000 minor) and 10,000 for vehicles. The average household claim for the flooding has been estimated at £30,000 and £40,000 (US$61,000 and US$81,000) for the June and July events, respectively. The commercial sector, although contributing fewer claims overall, has a higher price per claim – estimated at an average of £90,000 (US$183,000) per policy, including business interruption.

Fitch Ratings said on 24 July that the total cost to insurers from both events could exceed £3bn (US$6.2bn). Risk Management Solutions (RMS), meanwhile, estimated that the summer floods could cost insurers between £2.25bn and £3.25bn (US$4.6bn and US$6.6bn). RMS said it expects the losses from the June floods to total between £1.25bn and £1.75bn (US$2.5bn and US$3.6bn), while the company estimates that insured losses from the July event will range from £1bn to £1.5bn (US$2bn to US$3.1bn). The RMS loss estimate includes damage to property and vehicles and covers business interruption and alternative living expenses.

The summer floods, coupled with Windstorm Kyrill in January, which triggered losses of around £342m (US$700m) in the UK, is likely to make 2007 the most expensive year for insurers since 1990. Consequently, some insurance companies have already increased their rates.

TABLE 2: TEN LARGEST NATURAL CATASTROPHE INSURED LOSSES IN THE UNITED KINGDOM

Source: ABI

Rank	Date	Event	Original Loss (£m)	Adjusted Loss 2007 (£m)
1	January/February 1990	Storms and Flooding Across UK	2,081	3,370
2	June/July 2007	Floods	3,000	3,000
3	15-16 October 1987	Storm	1,050	2,089
4	October/November 2000	Floods	760	914
5	December 1981/ January 1982	Arctic Weather/ Rapid Thaw	250	630
6	January 1987	Severe Snowstorm	277	551
7	December 1995/ January 1996	Severe Snowstorm	320	427
8	December 1997/ January 1998	Storms and Flooding	270	342
9	January 2007	Windstorm Kyrill	342	342
10	February 1991	Severe Snowstorm and Flood	185	281

TABLE 3: FIVE LARGEST FLOOD LOSS EVENTS IN THE UNITED KINGDOM

Source: ABI

Rank	Date	Event	Original Loss (£m)	Adjusted Loss 2007 (£m)
1	June/July 2007	Floods	3,000	3,000
2	October/November 2000	Floods	760	914
3	January 2005	Floods in Carlisle	243	259
4	April 1998	Floods	137	171
5	October 1998	Floods	100	125

FIGURE 13: MORE THAN 100,000 HOMES AND BUSINESSES WERE FLOODED IN JUNE AND JULY IN THE UNITED KINGDOM

Source: IPR/95-10C BGS © NERC 2007. All rights reserved

Modelling Solutions for UK Flood

RMS was the only commercial modelling company that produced estimated flood area boundaries for the floods in June and July. At the time of the floods, only RMS had a UK river flood model, which was released in 2003. It is due to release a new model in 2008. AIR Worldwide also plans to release a UK flood model in 2008.

The existing 2003 RMS model contains both an 'on-plain' (fluvial) and 'off-plain' (pluvial) flood component. However, it was not possible to identify an event from the current stochastic set that resembled either of the summer events. RMS stated that:

"Due to the localised, broad geographical spread and evolving nature of flooding events, it is not realistic to match this event to stochastic events within the UK River Flood model. Reconstructing an event footprint is an extremely data intensive process to understand the full extent and depth of flooding and is not achievable within the timeframe of a CAT event response".

However, based on press research for the floods in June and additional reconnaissance work for the July event, RMS released a list of affected postcodes and published this list on its website.

Guy Carpenter's RealCat service provides insurers and reinsurers with accurate information on event extents and severities following catastrophe events. For the 2007 floods, Guy Carpenter was able to provide clients with the most accurate possible event extent information, enabling loss estimation and adequate reserving for impending claims. The event extent information compiled by Guy Carpenter was derived from a number of sources, including satellite data, post-event ground surveying and press research.

Satellite data is particularly important in creating an event footprint of this nature because it provides an accurate and immediate representation of locations where flooding occurred. By contrast, the ground-surveying method relies on the immediate deployment of a large team of people to the whole of the affected area. This can be a difficult task because not all areas will be

accessible, and there remains a danger that ground-based teams will miss some of the smaller affected areas. Another advantage of using satellite data is that it produces more accurate damage estimates than is possible from a list of postcodes. While the exact proportion of affected area for each postcode can be determined using satellite data, only conservative estimates can be obtained using a list of postcodes on the ground.

In areas where satellite imagery was not available, Guy Carpenter obtained ground reconnaissance information to determine flood extents. This work focused in particular on fluvial flooding in Sheffield, a city of high exposure for insurers. A team of trained surveying staff from JBA Consulting carried out reconnaissance work in Sheffield immediately after the June floods, providing observational information coupled with GIS co-ordinates. The resulting flood outlines are accurate to within 1 m to 2 m (3 feet to 6.5 feet).

Finally, in areas where neither of the above preferred sources of information was available, published information from other sources was used to supplement the event footprint. The resulting polygonal flood event extent information was combined with postcode data to create a table listing affected postcodes, and the percentage of flooding for each. Finally, Guy Carpenter used its G-CAT technology to calculate the number of affected properties per postcode for each portfolio analysed, enabling the number of affected risks and total value to be calculated. In areas where only the identity of the affected postcode was available (and not the proportion of its affected area), the estimate is expected to be conservative. Results from RealCat compare well with early estimates of losses from insurers affected by the floods.

Section 2 The Insurance Industry and Floods in the United Kingdom

Major observations from section two:

- More than two million homes are at risk from coastal or inland flooding in the UK.
- The overtopping of riverbank defences due to the large volume of water during the 2007 floods highlighted the inability of the UK's current flood defences to cope with the largest flood events.
- The ABI argues that the increases in spending that the government has pledged for flood defences between 2008 and 2011 are not enough.
- The ABI says the government needs to invest more money in flood defences if its members are to maintain their commitment of providing flood cover for as many residents as possible.
- The UK government has unveiled plans to build around three million new homes by 2020, and some of these will be built on floodplains if the 'proper defences' are in place.
- The 2007 summer floods had a significant impact on the direct insurance industry, but the proportion of loss passed on to reinsurers was limited.

Flood Risk in the United Kingdom

According to the ABI, more than two million homes are at risk from coastal or inland flooding in the UK (or around 10% of the 23.5 million properties), while around 400,000 homes are at a very high risk of flooding (greater than 1.3% annual probability or 1-in-75 chance). The overtopping of riverbank defences due to the large volume of water during the 2007 floods highlighted the inability of the UK's current flood defences to cope with the largest flood events.

Unlike the United States and parts of Europe, flood cover in the UK is widely available through a standard feature of household and most business policies. The ABI, through its 'Statement of Principles on the Provision of Flood Insurance', says that its members are committed to providing flood cover for as many residents as possible, but further states that successful operation of its policy is dependent on government action to manage flood risk effectively. The ABI has hardened its position since the 2007 floods and is pressing the government to invest more money in flood defences if it is to sustain its current commitment.

The Government's Role

In England and Wales, overall policy decisions regarding flood management are guided by the Department for Environment, Food and Rural Affairs (DEFRA), while implementation and management of defence schemes are handled by the EA. Since the flooding in the summer of 2007, DEFRA has announced an independent chair to review lessons learned from the floods.

The EA provides homeowners with information on the extent of floodplain areas and proposed defence improvements. It also provides flood warnings and advice on how to prepare for a flood. Some 400,000 homes are in areas at high risk of flooding (i.e. expected to be flooded once in 75 years or more frequently). The EA says there are 24,000 miles of flood defences and 46,000 flood defence structures protecting properties in England and Wales. The EA must be consulted in the case of new developments on floodplains, but it cannot overrule the government on development decisions. Moreover, the consultations do not mitigate the risk faced by those who already live in exposed areas.

To reduce risk in some areas, the government announced an increase in annual spending on flood defences to £800m (US$1.6bn) a year in 2011 from the current £600m (US$1.2bn) a year. The increase was initially welcomed by the ABI but following the summer floods, the organisation called for the increase to be brought forward and criticised the government for only agreeing to spend £2.15bn (US$4.4bn) on flood defences between 2008 and 2011 in its Comprehensive Spending Review instead of the £2.25bn (US$4.6bn) called for by the ABI.

Moreover, the additional spending on defences is likely to be of little solace for those seeking insurance protection in undefended areas where defence improvements are not scheduled. The ABI's commitment to provide insurance cover in areas with a significant risk of flooding clearly distinguishes between areas where flood defence improvements are planned and those where they are not.

Even with greatly improved defence systems, the EA stresses that flooding risk can never be completely eliminated. Therefore, from a policy point of view, there is a need for the insurance industry to continue to provide indemnity to clients in relation to flood claims while flood risk mitigation remains an important part of future government strategies, especially in areas where insurance companies refuse to offer cover or where premium rates are very high.

Construction on Floodplains

Development on floodplains is an important part of this process. The EA provides all regional and local planning authorities with information on flooding issues, and advises on the preparation of their development plans and associated strategic flood risk assessments. It also advises potential developers on site-specific flood risk assessments. In total, it consults on around 60,000 planning applications per year.

The EA is opposed to inappropriate development in flood risk areas and advocates the restoration of floodplains to enable them to function naturally. However, its advice is not always taken up and, in some instances, it has not even been consulted at all. The agency has objected to a number of house-building proposals in recent years, but up to 20% have still been approved. (In 2007 alone, local authorities gave planning permission for 14 major developments and 90 minor projects against EA advice.) Estimates also suggest that the agency may be consulted on less than 60% of applications at risk of flooding.

The issue was publicised further in July 2007 when the UK government unveiled plans to build around three million homes by 2020. While the government said that as many as 66% of these properties are likely to be built on brownfield building sites, it admitted some of these new homes would be built on floodplains if the 'proper defences' are in place. The government added that under new rules outlined in the Housing Green Paper, ministers are prepared to overrule councils that did not heed EA advice on housing plans, and no new construction should take place in areas with high flood risks "if better alternatives can be found in the same area". Despite such reassurances, the ABI warned against building new homes in floodplain areas and argued that any construction must be planned and designed with flooding in mind.

However, the high demand for property in the UK, particularly in the south-east of England, is likely to see continued development on floodplains. The Thames Gateway regeneration project illustrates this well with an estimated 200,000 properties likely to be built in the area, much of which is classed as a floodplain. Such projects emphasise the importance of how insurance companies manage future flood risk in the UK.

Reinsurance of Flood in the United Kingdom

Floods may have a significant impact on the direct insurance industry. However, the proportion of loss passed on to reinsurers following the 2007 floods was limited, and the effect on the global results of reinsurers is expected to be negligible. There are two significant factors that determined this allocation between insurers and reinsurers.

Firstly, most catastrophe excess of loss wordings have an hours clause. This attempts to split catastrophe events that exceed a certain duration into individual loss occurrences, which are defined periods of time for each peril. The start of a loss occurrence is usually decided by the reinsured and subject to certain conditions specified in the wording. The application of hours clauses came into play for most catastrophe programmes for the 2007 floods due to the length of the event, and for most cedants the 2007 floods were separated into two events, resulting in two catastrophe programme retentions.

Secondly, the last few years have seen a steady increase in attachment levels for UK and pan-European catastrophe programmes. This increase has been driven by mergers and acquisitions, efforts to control reinsurance costs and an increasing focus on capital management. On average, UK catastrophe programmes now attach at around a 1-in-10 year return period, which equates to an estimated £1.5bn (US$3.1bn) insured loss.

Despite the application of hours clauses and the trend for increased catastrophe retentions in the UK, some programmes with lower-than-average attachment points were hit, although losses have typically been limited to first layers.

More than seventeen years have now passed since the storms in January and February of 1990, the last major catastrophe in the UK to have a material upwards effect on pricing. Catastrophe layers that were hit by flood losses in 2007 are likely to see some mild pricing increases at renewal, however, there is not likely to be a significant upward shift in UK catastrophe pricing because of the 2007 floods. A greater focus by insurers and reinsurers on exposure management for the flood peril is expected as well as further discussion based around the hours clause for flood.

In addition to some catastrophe losses, there were a small number of large commercial individual losses from the floods, which resulted in losses to some per risk programmes. The ability to collect individual risk losses depended on the 'risk definitions' in per risk contracts as in some instances individual policies suffered losses at multiple locations that were spread over a large area.

The combination of increased retentions for UK catastrophe programmes and a frequency of small to mid-size events (such as Kyrill and summer floods in 2007) is expected to lead to an increased interest in aggregate covers that will pick up a frequency of losses that fall beneath the retention of the catastrophe. There were a small number of these contracts purchased in 2007 and in general they responded well to the frequency of events.

Alternative Risk Transfer Techniques

In light of the summer floods, discussion within the insurance industry is also focusing on Alternative Risk Transfer techniques for managing flood risks, in particular the use of catastrophe bonds. Cat bonds take the form of securities sold into the capital markets, usually through a private placement. The bonds offer insurers the ability to transfer risks that they do not want to hold themselves, including exposure to low-frequency/high-severity perils such as earthquakes, hurricanes and floods.

To date, over US$20bn in cat bonds have been issued globally, covering a number of perils and territories. Earlier this year, the first cat bond covering flood risk was issued. The US$150m Blue Wings cat bond allowed German insurer Allianz to transfer to the capital markets potential river flood losses in the UK as well as earthquake damage in Canada and the US, excluding California.

The Blue Wings transaction was structured using a parametric trigger. This means that the potential for Allianz to claim on the bond is linked to a predetermined set of parameters that reference flood depths at over 50 locations in the UK, with various weightings used to calculate an overall index.

There is tremendous potential for insurers to use innovative capital markets solutions to deal with river and coastal flooding in the UK and beyond. Other innovations could involve the use of a UK-wide flood index or aggregate industry loss index, on which index-linked cat bonds, Industry Loss Warranties or derivatives could be traded.

Section 3 Flood Types and Climate Change Implications

Major observations from section three:

- Several flood types exist in the UK. Fluvial flood is the main cause of flood loss in the country as it has the potential to affect several rivers and cause damage over a wide area.
- Increases in property values and development (particularly if inadequately controlled in floodplain areas) can increase insurers' exposure faster than the impact of climate change.

Review of Flood Types in the United Kingdom

Fluvial flood is the main cause of flood loss in the UK as a single event because it has the potential to affect several rivers and cause damage over a wide area. However, as the 2007 floods demonstrated, fluvial flood is only one of several types of flood that occurs in the UK. In addition to fluvial flooding, large parts of the UK are exposed to pluvial flooding caused by heavy rainfall overwhelming inadequate drainage, as evidenced by the floods in Hull in 2007. Each flood type has its own damage potential. Table 4 shows the different types of flood that exist in the UK.

TABLE 4: DIFFERENT FLOOD TYPES THAT AFFECT THE UNITED KINGDOM

Type of Flood (Recommended Terminology)	Other Commonly Used Terminology
Storm Surge Flooding	Sea Surge
Fluvial Flooding	On-Plain River Flooding
Pluvial Flooding	Off-Plain/Flash
Groundwater Flooding	
Sewer Flooding	Urban Flood
Seepage	
Dam Failure Flooding	

This section describes the different flood types in the UK and explains how they occur.

Fluvial Flooding

Fluvial flooding is driven by meteorological conditions that create large discharge events in rivers and it occurs when river levels overtop or breach defence structures.

The breaching of a defence is dependent upon the loading of the water and the nature and conditions of the defence. For instance, vegetation and animals can significantly reduce the strength of levees.

Fluvial flooding can occur on a large scale when precipitation events are sustained over a sizeable area and long period of time or on a more localised basis when rainfall is extremely intense over a small area (e.g. summer thunderstorms).

There are several examples of fluvial flood events affecting the UK, and it was this type of flood that accounted for the bulk of damage in July 2007. The previous large fluvial flood event in the UK occurred in 2000, when parts of England and Wales were inundated after several rivers burst their banks, damaging thousands of buildings and triggering insured losses of more than £900m (US$1.9bn) in 2007 prices.

FIGURE 14: EXAMPLE OF FLUVIAL FLOODING IN THE UK DURING JULY 2007 EVENT

Pluvial flooding

Pluvial flooding is caused by excessive rainfall that runs off the surface and accumulates in low-lying areas. This occurs during periods of wet weather when the soil becomes so saturated that it cannot absorb any more water. Eventually, this runoff water will reach a river and can potentially contribute to a fluvial flooding event.

There is a greater risk of pluvial flooding in urban areas because of the impermeable soil surface conditions but it can also occur in open land. This type of flooding tends to be more localised than fluvial flooding because of the nature of the precipitation event. This was well illustrated during the floods in June 2007. Hull, in particular, was badly damaged as drainage systems were unable to cope with the heavy rainfall. The fallout from the floods in Hull fuelled calls for a rethink on whether drainage systems designed only to cope with a 1-in-30 year storm event are sufficient for the future, especially with concern over the impact of climate change.

Storm Surge Flooding

Storm surge flooding is a consequence of a rise in the sea level, created by low-pressure weather systems. A surge is the meteorologically driven component of the sea level; it is the difference between the observed sea level and the astronomical tide level.

Two meteorological components need to come together during the generation of a surge, namely low air pressures and certain wind conditions. The water level rises as air pressure decreases, yet this component has a limited influence on the total surge amplitude. The most important process is the dynamic action of wind on the water surface, pushing the water towards the coast.

Large storm surges occur in places affected by large storm events (typically hurricanes and windstorms) or in places with special local topography and bathymetry conditions, such as estuaries and bays. The North Sea can be considered as behaving like a large estuary, having a wide inlet in the north and a narrow outlet in the south.

Storm surge flooding can occur on a large scale. It takes place when the sea level exceeds the crest height of the defences (overtopping) or when a combination of static loading of the water column and the action of the waves on the defences, breach the flood defences.

The greatest storm surge event to hit the UK occurred in the North Sea on 31 January and 1 February 1953, devastating the Netherlands and the east coast of England. A high spring tide and a severe European windstorm resulted in a storm surge of up to 3.36 m (11 feet) that overtopped sea defences and caused severe flooding. In England, around 300 people were killed and around 24,000 houses were destroyed at an inflation-adjusted insured cost of around £5bn (US$10.3bn).

Groundwater Flooding
Groundwater flooding is driven by the amount of precipitation that infiltrates into the soil and reaches the groundwater table. If the precipitation conditions are sustained over a long period, the water table can reach the soil surface and overflow.

Groundwater flooding can occur over a large area and be of long duration due to the dynamic of groundwater bodies. For instance, in 2001 some houses in the Somme basin in France were flooded with more than 2 m (6.5 feet) of water for two months.

Sewer Flooding
Sewer flooding occurs:

> when an area is hydraulically connected to a flooded zone only via the sewer system. In such cases, the sewer network acts as a bypass of the surface hydraulic network;

> when the sewer network reaches saturation and overflows in a low-lying area.

Sewer flooding generally occurs at a localised level and can only be modelled at a very small scale using hydraulic models because of the detailed data required.

Seepage
Seepage is an infiltration of water through a structure and can vary in size. For example, seepage can occur when groundwater infiltrates through a basement wall to affect a single house, while river water levels can also infiltrate levees and affect a large area.

Dam Failure Flooding
The failure of large dams can result in devastating waves of water travelling at very high speed. Two separate processes can cause the failure:

> technical processes – including insufficient design that means the dam cannot empty the excess water from the reservoir during extreme discharge events, and the ageing of the construction materials;

> natural processes – including seismic activity and a landslide that produces a large wave within the reservoir.

There are around 140 dams in England, with several located in northern regions of the country that could have catastrophic consequences if they were to fail. During the June 2007 flood event, hundreds of people from three villages in South Yorkshire fled their homes amid fears that the Ulley dam was about to burst. Although on this occasion firefighters and engineers stabilised the dam by pumping out water, the fact that 700 people were evacuated and part of the M1 motorway was closed because it would have flooded had the dam burst, illustrates the destructive potential of dam failure flooding.

Climate Change

The first part of this section explained how the UK is threatened by several different flood types. Flood risk looks set to increase because of continued plans for construction in floodplains. The extreme weather during 2007 has also fuelled the debate about whether climate change played a part in triggering the floods and what the UK can expect in the future. This second part looks at climate change issues.

The UK experienced one of its driest years in 2006, followed in 2007 by its wettest ever. Some commentators have argued that climate change may have contributed to the extremity. While high pressures dominated the UK weather scene in 2006, 2007 saw a series of low pressures moving across the country that brought heavy rainfall and caused soil saturation over an extended period.

The weather pattern in the UK is determined by the course of low-pressure systems that track across the Atlantic. As explained in section one, the jet stream is normally situated north of the UK during the summer months, steering low pressures away from the country. However, in 2007 the jet stream was located further south than normal, directing these systems towards the UK. In addition, the troughs formed over warmer water and were able to carry more moisture and the associated weather systems slowed down until they were almost stationary. This caused heavy and prolonged rainfall in June and July. But was the extreme rainfall a consequence of climate change and what are the implications for the future?

A study produced by the Intergovernmental Panel on Climate Change (IPCC) suggests that climate change is likely to bring mixed effects to the UK over the next few decades. The IPCC said the UK is likely to see an increase in temperature, but as climate change continues, negative effects such as more frequent winter flooding are predicted. However, more uncertainty exists about how climate change will influence rainfall during the summer months in the UK.

According to the Met Office's climate change projections, the frequency of extreme rainfall events may increase and the wettest days in the summer are likely to become even wetter. The understanding is that this is because warmer air has the potential to hold more moisture than cooler air, leading to higher rainfall rates in a warmer world.

Other Met Office projections indicate that the summers are generally expected to become drier rather than wetter, and yet the summer of 2007 was the wettest on record. Furthermore, the general understanding that depressions that are formed over warmer water can carry more moisture seems to have been contradicted in 2007 as sea surface temperatures (SSTs) around the UK were cooler than normal.

Predicting rainfall trends in the future, particularly at country and local level, remains a real challenge. Clearly, many questions remain on how climate change will affect the UK, especially at local level. Continued research and an improved understanding of the climate system will help provide some clarity in the future.

Essentially, it is not possible to come to any conclusions about climate change based on what happened in the UK over the past couple of years. Although the rainfall during the summer of 2007 was extraordinary, this sort of event can occur whether climate change is happening or not (1812 and 1947 both saw larger floods and RMS estimates that the latter would cause an insured loss of £4.5bn to £6bn if it happened today). In fact, increases in property values and development (particularly if inadequately controlled in floodplain areas) can increase insurers' exposure faster than the impact of climate change, and the only real lesson the insurance industry can learn from the events of 2007 is that it needs to adapt to changing weather patterns whatever the cause.

Conclusion

This report has shown that flood in the UK is a persistent and potentially costly risk. Several flood types exist in the country, each with its own damage potential. The heavy rainfall during the summer of 2007 triggered the worst flooding in 60 years and led to the largest flood-related loss to date. The events in June and July resulted in more than 130,000 insurance claims being submitted at an estimated cost of £3bn (US$6.2bn), and illustrated the level of damage and disruption flood is capable of causing in the UK. The cost of flood damage was largely borne by the UK insurance industry and only a relatively small proportion of the losses were ceded to reinsurers.

More than two million homes are currently at risk from coastal or inland flooding in the UK and there are plans to build three million new homes by 2020, with a significant proportion on known floodplains. Coupled with changing weather patterns and the potential impact of climate change, this means that the level of flood risk in the UK looks set to increase and it highlights the importance of managing exposure to flood.

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Wrong Type of Rain:
Impact and Implications of 2007 UK Floods

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