
# December 1703 Windstorm

## 300-year Retrospective

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# INTRODUCTION

The December 7-8, 1703 Windstorm (November 26-27 on the old calendar still used in England at the time) was the most damaging to have affected the southern part of Britain for at least 500 years. The fame of the storm owes much to the fact that it cut a swathe of damage through London, where a recently imprisoned former tile-manufacturer named Daniel Defoe cut his journalistic teeth by placing a newspaper article soliciting accounts of damage and deliverance that he went on to publish in a book: 'The Storm' (1704).

While Defoe's survey comprises a series of 'snapshots' of the impacts of the storm in towns and villages across southern Britain, the impacts in continental Europe have never been compiled. Continental Europe had already passed onto the modern Gregorian calendar (not introduced into Britain until 1752) and was therefore eleven days ahead of England: where the storm was dated November 26-27. The windfield also extended across the front-line in the long-running War of the Spanish Succession: that pitted France (including what is now Belgium) allied with Spain and Bavaria against Netherlands, with England and most of the German states. Newspapers on the continent were on one or other side in this conflict and colored their accounts of the storm accordingly, damning their enemies' ports to imagined destruction while covering up their own losses.

Available synoptic meteorological information reveals that this was a large deep and fast moving 'daughter' depression, with a central pressure falling to around 950 mb, embedded along the southern flank of an enormous and deep depression centered to the northeast of Scotland, and flanked by a band of high pressure over France. The track of the storm centre passed over the English Midlands across the North Sea into northern Denmark, moving at a steady 45 mph: with the highest winds hitting southwest Wales at 3 am, London at 6 am and Copenhagen around 11 am (on December 8). The preconditions out in the Atlantic during December 7 must have been similar to the 225 mph windspeeds in the jet-stream that pointed towards northern France on Christmas Day 1999, but the jet-stream on December 7, 1703 pointed east-north-east at the coast of Wales, and in place of the two separate daughter depressions 'Lothar' and 'Martin', this was the equivalent of the energy of the two storms rolled into one.

# IMPACTS

The City of London had been entirely rebuilt after the 1666 Great Fire of London, and thatch had been prohibited for use in roofing to reduce the fire hazard. After the storm: 'the streets lay so covered with Tiles and Slates, from the Tops of the Houses, especially in the Out-parts, that the quantity is incredible, and the Houses were so universally stript, that all the Tiles in Fifty Miles round would be able to repair but a small Part of it'. Approximately 2,000 massive stacks of chimneys were blown down in and about London, along with gable ends of Houses, some whole roofs and 16-20 entire houses on the edge of the town.

The level of damage was similar in many towns and villages across southern Britain, with the majority of houses partly or completely stripped of tiles. As in London, a significant number of houses were demolished by the collapse of a central chimney stack. In all more than 800 dwelling houses were blown down, and in the county of Kent there were over 1,000 out-houses and barns destroyed. One hundred churches had the lead sheeting rolled up or blown off their roofs, as well as pinnacles dislodged, windows broken, and in a few cases, steeples collapsed into the remainder of the structure. Of all buildings, the most vulnerable were windmills with more than 400 either toppled and broken, or burnt to the ground after the sails rotated at such speed as to cause the axles and brake to overheat and catch fire. There was widespread destruction of millions of trees in forests, parks and orchards.

On the European continent, local levels of damage in some coastal towns in northern Belgium and Netherlands were almost as intense as those in England. Somewhat lower levels of damage extended into parts of Denmark, including Copenhagen and Aalborg. On the southeast flank of the storm there was a narrow band of more intense damage running 400 km to the northeast from near Dusseldorf all the way to Rostock on the Baltic Coast along which the tallest church spires had been blown down.

The windstorm drove a major storm surge into the inner Severn Estuary, flooding villages along the northern coast of Somerset as well as the centre of the City of Bristol with its docks and warehouses. Along the English Channel the surge combined with intense wave action and at the village of Brighthelmstone (today's Brighton), the lowermost street of houses was washed away, making 'the very picture of desolation, that it looked as if an enemy had sacked it'.

Although the storm in England occurred entirely at night, when casualty rates are around a quarter of daytime, 123 people were killed on land in England and Wales, due to the collapse of roofs and chimneys. Twenty-one people were killed by falling stacks of chimneys in London, with 200 severely wounded and maimed. At least another 20 died in damage in continental Europe. Around 80 people are known to have drowned in their cottages in the marshland along the Severn estuary, with tens of thousands of sheep and cattle. Even these totals are dwarfed by the estimated 8,000 killed in more than 100 shipwrecks at sea.

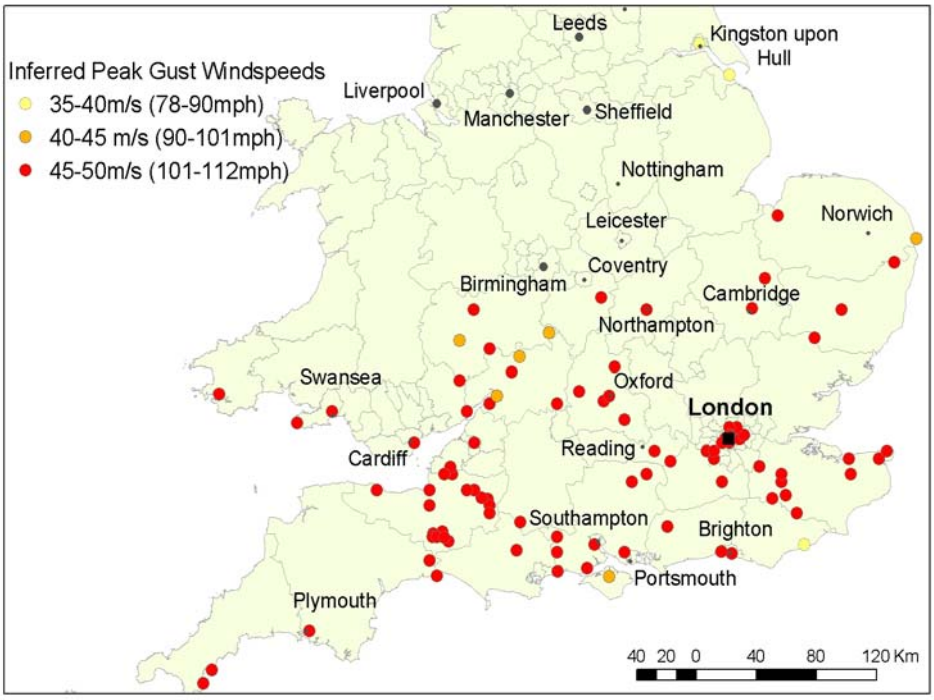
# RECONSTRUCTING THE WINDFIELD

Based on studies to relate windspeeds in the October 1987 and December 1999 windstorms to damage levels of comparable buildings such as Medieval churches, 17th Century barns and houses as well as trees, RMS has reconstructed the windfield footprint of the 1703 storm. This reconstruction shows that in a series of bands 20-30 km wide and extending over London and Bristol and some surrounding areas, peak windspeeds reached 45-50 m/s (100-110 mph), comparable to those of a Category 2 hurricane. The area in which windspeeds were consistently above 40 m/s (90 mph) was approximately 180 km wide: almost twice the equivalent width of the October 15-16, 1987 and December 26, 1999 Lothar windfields. The edge of this zone of intense winds just clipped the southern coast of SE England, with damage levels reflecting windspeeds of around 70-80 mph across the Isle of Wight and at the town of Hastings.

The bands of extreme windspeeds are typical of a very intense 'sting-jet' extra-tropical cyclone, when dramatic intensification associated with a very high-velocity jet-stream leads to the wrapping of the warm front around the low-pressure centre. The conjunction of the warm and cold dry air to the southwest of the storm centre drives intense slant-wise convection and the creation of a pulsed low-level jet that brings very high windspeeds down to ground level.

The existence of localized low-level jetting is also revealed by some first hand accounts: as at Bruton in Somerset where an observer noted that 'the Wind did not come in a full body at once, but it came in several Gusts as myself have taken Notice … that in half a miles riding, I could not see a tree down, not much hurt to Houses, then again I might for some space see the trees down, and all the houses shattered, and I have taken notice that it ran so all up the Country in such a line as the wind sat.'

The sting-jet has been the subject of much discussion since the joint RMS-Reading University and U.K. Met Office exhibition at the U.K. Royal Society in June 2003. The most intense phase of the storm lasted 6-8 hours as it crossed the landmass of Britain and passed over the southern North Sea. The bigger the storm the longer the sting-jet can be re-supplied by circulating warm air. The band of NE trending damage across Germany appears to have been associated with very intense convective activity along the trailing cold front of the storm.




*Windspeeds reconstructed from damage data for the 1703 storm*

# FINANCIAL LOSS

The population of England and Wales in 1700 was 5.84 million, with a large majority living in the southern half of the country. London was by far the largest city with a population of 350,000 to 400,000. Bristol with a population approaching 35,000 was the 3rd richest city in England and the greatest port outside London.

At Bristol, the total losses were estimated to be £100,000, equivalent to £3 per person in the city, or about £10 per property, which was the equivalent to 15 to 20 weeks average wages. Total losses in London were estimated to be £2 million. Average property values and roofing costs were lower outside the principal cities so that the average building repairs over the whole of the affected area were £5-£6 per property: representing around £6 million as the total direct damage in the storm: more than the £4 million losses in the Great Fire of London when 14,000 properties and domestic and merchant property were destroyed.

The total value of the building-stock of England and Wales at this time was only around £100-150 million, so this represented a very significant national disaster, comparable in its regional impacts to recent catastrophes that have affected developing countries, such as Hurricane Gilbert in Jamaica in 1988. However the damage was evenly distributed among rich and poor alike and having suffered a civil war, plague and famine winters in the previous decades, one Somerset farmer reflected 'our loss in the apple-trees is the greatest; because we shall want Liquor to make our hearts merry'.

The storm provoked a building boom and caused one of the best documented and earliest examples of price gouging. The price of tiles in London rose 400-500%, the cost of building labor increased by 200%, while in the country prices of straw for thatching doubled. Prices started to fall again once it was clear that people were not prepared to pay these premiums, preferring to leave their roofs uncovered, or protecting them with sheets of cheap timber planking until building prices fell back to pre-Storm levels. Even major buildings such as the principal London hospitals and the London Temple, remained with their roofs boarded for more than a year. In the country, the shortage of tiling and thatching forced house-holders to cover their roofs with planks, old tiles, pieces of sail cloth and tarpaulin.

# THE 1703 WINDSTORM TODAY

A repeat of the 1703 windstorm today would be catastrophic in its impacts to buildings, casualties, electricity supply and transport, as well as to the consequent economic and insurance impacts.

Individual building values have increased by around x 5,000 since 1700, while the population of the southern part of England has grown by a factor of more than 10. However these multipliers cannot simply be employed for factoring the loss, because roofing standards and the quality of the mortar used in chimney stacks have also improved for most buildings, and the roof represents a smaller proportion of the total value of a property than it did in 1703.

There are far more trees in and around houses today than in 1700, when among all of Defoe's descriptions of damage there is no mention of a tree falling on a building. However even then 'so many trees were everywhere blown across the Road, that till the People were called to saw them off and remove them, the ways were not passable.' As in France after windstorms Lothar and Martin in 1999, millions of customers would be without power after a repeat of the storm, with power-cuts lasting for more than a month in rural areas.

If the repeat of the storm, as in 1703 occurred at night then one could expect 40-60 deaths due to falling trees and collapsing chimney stacks, and in mobile homes: as were the principal cause of deaths in the 1987 storm. If the storm occurred in the daytime without any effective warnings, then fatalities could easily exceed 200, many hit by missiles off roofs or falling trees while walking, or by impacts between cars and trees, or by the destruction of the most vulnerable buildings such as temporary school classrooms.

There are currently around 18 million properties in the footprint of damaging winds of the storm in the U.K. alone. In defining the reconstructed windfield of the storm and superimposing it on the current building stock, the insured losses from a repeat of this storm today in the U.K. would be an estimated £10 billion ($16 billion), bigger than the loss from a repeat of the 1938 Hurricane through New England. From what has been discovered about the extent of damaging winds across continental Europe there would be another estimated £1-2 billion ($2-3 billion) damage, principally in the Netherlands, Germany, and Denmark but also Belgium. For today's industry exposure this storm represents the largest European windstorm loss known in the past 500 years, both for the U.K. and for the whole of Europe. For many U.K. insurers the loss would significantly exceed their current reinsurance provisions and could threaten their viability.