



Worcestershire Local Climate Impacts Profile

Table of Contents

1 Introduction	5
1.1 Background.....	5
1.1.1 Purpose of the LCLIP.....	5
1.2 The vulnerability of Worcestershire	6
1.2.1 Geology and topography	6
1.2.2 Rivers	6
1.3 Climate of Worcestershire	6
1.3.1 Weather and climate.....	7
1.3.2 Climate change	7
1.3.3 Defining severe and extreme weather	9
2 Impacts of severe weather on Worcestershire	10
3 Impacts of severe weather events on services	27
3.1 Flooding 1998	27
3.1.1 Insurance- Worcestershire County Council	27
3.2 Flooding 2000	27
3.2.1 Insurance- Worcestershire County Council.....	27
3.3 Storms 2002-2003	27
3.3.1 Insurance- Worcestershire County Council.....	27
3.4 Heatwave 2003	27
3.4.1 Adult and Community Services- Worcestershire County Council	28
3.4.2 Agriculture and biodiversity	28
3.4.2 Hereford and Worcester Fire and Rescue Service.....	28
3.4.4 National Health Service (NHS).....	28
3.5 Lightning 2003-2004	29
3.5.1 Insurance- Worcestershire County Council.....	29
3.6 Snow and ice 2005-2006	29
3.6.1 Insurance- Worcestershire County Council.....	29
3.7 Lightning 2005-2006	29
3.7.1 Insurance- Worcestershire County Council.....	29
3.8 High Summer temperature 2006	29
3.8.1 Adult and Community Services- Worcestershire County Council	29
3.8.2 Agriculture and biodiversity	29
3.8.3 Hereford and Worcester Fire and Rescue Service.....	30

3.8.4 Highways and Transport- Worcestershire County Council	31
3.8.5 National Health Service (NHS)	31
3.9 Lightning 2006-2007	31
3.9.1 Hereford and Worcester Fires and Rescue Service	31
3.9.2 Insurance- Worcestershire County Council	31
3.10 Storms 2006-2007	31
3.10.1 Insurance- Worcestershire County Council	31
3.11 Snow February, 2007	31
3.11.1 Insurance- Worcestershire County Council	31
3.12 Flooding 2007	31
3.13 Flooding, June 2007	32
3.13.1 Adult and Community Services- Worcestershire County Council	32
3.13.2 Agriculture and biodiversity	32
3.13.3 Children's Services and Property Services- Worcestershire County Council	32
3.13.4 Countryside Service- Worcestershire County Council	33
3.13.5 District Councils	34
3.13.6 Environment Agency	34
3.13.7 Tourism	34
3.13.8 Highways and Transport- Worcestershire County Council	34
3.14 Flooding, July 2007	34
3.14.1 Adult and Community Services- Worcestershire County Council	35
3.14.2 Agriculture	35
3.14.3 Biodiversity	37
3.14.4 Children's Services and Property Services- Worcestershire County Council	37
3.14.5 Countryside Services- Worcestershire County Council	39
3.14.6 District Councils	39
3.14.7 Emergency Planning Unit- Worcestershire County Council	41
3.14.8 Environment Agency	42
3.14.9 Hereford and Worcester Fire and Rescue Service	43
3.14.10 Highways and Transport- Worcestershire County Council	43
3.14.11 Insurance- Worcestershire County Council	43
3.14.12 National Health Service (NHS)	44
3.14.13 Tourism	44
3.14.14 Waste Management- Worcestershire County Council	45

3.15 October 2007- October 2008	45
3.16 January 2009- June 2009	45
3.16.1 Snowfall, February 2009.....	45
3.17 Snowfall, December 2009	46
3.18 Snowfall, January 2010	46
3.19 Snowfall, February 2010	46
4.0 Future climate projections	47
4.1 Future climate projections for Worcestershire.....	47
4.1.1 Temperature projections.....	47
4.1.2 Precipitation projections	48
4.2 Severe weather	48
5.0 Summary.....	49

1.Introduction

1.1 Background

The Local Climate Impacts Profile (LCLIP) is a methodology developed by the UK Climate Impacts Program (UKCIP) to help local authorities assess and better understand how they are, and will be, affected by weather and climate. UKCIP was set up in 1997 to help organisations prepare and adapt to future changes in the UK climate.

The Local Climate Impacts Profile focuses on a chosen time window that allows for the assessment of how an organisation's services, buildings etc. have been affected by different extreme weather events. As well as Worcestershire County Council, the report also included the assessment of impacts on the Environment Agency, NHS and Hereford and Worcester County Fire Service. In large part, owing to its geography, Worcestershire is particularly vulnerable to incidences of flooding.

1.1.1 Purpose of the LCLIP

It is important that Worcestershire County Council and partners have an awareness of their environment and expected future changes and possible risks. Over recent years this LCLIP shows how the county has been affected by extreme weather events; such as flooding from rivers, flash flooding, high temperatures and a number of storms. These have affected large proportions of the county's population. Weather events such as these impact upon the everyday functioning of society including the operation of County Council and other organisations' services. The UK climate is changing and future projections predict that the intensity and frequency of unusual weather will increase.

The purpose of this study is to assess the impact weather events have had on Worcestershire County Council services and other organisations with a view to highlighting the services most affected and extra costs incurred. By using local newspaper archives it has been possible to obtain an idea of the consequences of extreme weather conditions. Further information has been gathered from relevant County Council services to form impact reports for each incident. By using data from the UK Climate Impacts Programme it is possible to assess future climate predictions for the county.

Aims

- To raise awareness of the impacts of extreme weather events and the influence of climate change on County Council and other sectors
- To assess the costs these weather events have had on County Council and other sectors
- To provide evidence for the need for adaptive measures
- To highlight the possible future impacts of climate change.

Objectives;

- To produce an account of extreme weather events that have affected Worcestershire since 1997
- To provide information on predicted changes in extreme events as the climate alters
- To discuss the impacts of each event with relevance to the County Council and other services
- To highlight the cost and recurrence interval of each event

- To use future predictions of climate change and extreme weather to assess how services may be affected as weather systems alter further.

This research is used as a basis for work towards National Indicator 188, planning to adapt to climate change which the Worcestershire Partnership have accepted as a priority indicator for the period 2008-2011. The Worcestershire LCLIP will help to inform the Worcestershire County Council climate change risk assessment and ultimately the adaptation action plan.

1.2 The Vulnerability of Worcestershire

Worcestershire is situated in Central England and is home to approximately 555,400 (May 2007) inhabitants; by 2011 the population is expected to have risen to 576,500 (*Worcestershire County Council, 2007*). In Worcestershire, the environment, geology and climate will play an important role in the vulnerability of the County to future weather events.

1.2.1 Geology and Topography

The dominant geology of the County is clay, which has a fairly low absorption capacity for water. This increases the likelihood of flooding incidences (*British Geological Survey, 2007*) and alters the likelihood of subsidence (if clay soils dry out, the subsidence risk increases).

This geology gives rise to a predominantly pastoral landscape. Probably one of the most notable topographic features is the Malvern Hills, volcanic igneous and metamorphic rocks that tower 425m between Herefordshire and Worcestershire (*DEFRA, 2007*).

1.2.2 Rivers

There are three main rivers in Worcestershire with a number of towns and cities located on their banks. The River Severn, the longest river in Britain, has two major tributaries in Worcestershire, the Avon and the Teme. On the banks of the River Severn can be found the settlements of Worcester, Bewdley and Upton-upon-Severn. To the east on the River Avon are Evesham and Pershore while the River Teme, joining the Severn at Powick, passes by Tenbury Wells.

1.3 Climate of Worcestershire

Combined, these natural features make Worcestershire vulnerable to changes in the climate system. Increases in the intensity of rainfall events will lead to more rapid run off of water into watercourses raising the risk of fluvial flooding. Hard impermeable surfaces associated with urban centres will increase the amount of water running directly to the river systems during intense rainfall events. With the rivers unable to cope with this amount of additional water in a short space of time, riverside homes and businesses will flood. At present, 4653 properties (2010 data) are thought to be at risk of a 1 in 100 year flood and 9039 properties at risk from a 1 in 1000 year flood in Worcestershire¹⁶.

As summer months become drier, the southern county agriculture may begin to suffer more from the effects of drought.

¹⁶ See contact references

Worcestershire’s climate has already changed from the baseline average and is forecast to continue to alter in the future (table 1.0).

Table 1.0 Worcestershire’s baseline climate and changes over the last century (Worcestershire Climate Change Impact Study, 2004)

Climate aspect	Baseline climate (1961-1990)	Changes over the last Century
Mean annual temperature	9.5°C	+0.6°C since 1900s
Mean max. temperature	13.4°C	
Mean min. temperature	4.9°C	
Mean annual rainfall	669mm	<ul style="list-style-type: none"> •Winters have become much wetter relative to summer months. •Rainfall intensity has increased
Mean number of snow days	17 days	Fewer and smaller snowfall events
Mean daily wind speed	8.5 knots	No long term trend in wind speed

1.3.1 Weather and Climate

It is necessary to distinguish between the terms weather and climate. Climate is defined as the average weather over a period of time (usually over 30 years). The weather is what is actually occurring at a particular time (ie. the conditions we see out of the window). The term climate change is used to infer how the baseline climate (the climate that we are used to annually) may change over time either as a result of natural variation or due to human interference.

1.3.2 Climate change

“Climate change is the most severe problem we are facing today, more serious even than the threat of terrorism.”
David King, UK Government Chief Scientific Adviser

Many experts now agree that the Earth’s climate is changing. The planet is warming at a faster rate than previously seen throughout geological history. This is in part, a result of natural variations such as shifts in solar output, volcanic activity and alterations in ocean circulation, but also due to human activities such as the burning of fossil fuels and resultant release of greenhouse gases such as carbon dioxide.

A number of key climate change issues are mentioned below:

- The extra greenhouse gasses being produced by human activity are trapping heat from the sun within the Earth’s atmosphere, thus leading to a general warming trend.

- Carbon dioxide (CO₂) levels are currently at 380 ppm (parts per million)
- Over the last century, global temperatures have risen by 0.8⁰C. A rise of less than a degree may not sound very spectacular but in a delicate system, slight alterations can have dramatic consequences (*Henson, 2006*)
- 1998 was the warmest year globally on record (*Met Office, 2008*)
- Europe experienced its worst heatwave in 2003 (*Met Office, 2008*)
- This warming trend is likely to continue if greenhouse gas emissions are not reduced and atmospheric concentrations stabilised
- Since the 1980s, the thermal growing season has lengthened by 3 weeks (*Environment Agency, 2007*)
- The occurrence of El Nino^a events in the Pacific Ocean may add to the warming conditions during some years (*Henson, 2006*)
- Since the 1980s, 12 bird species have shifted further north in Britain as the climate has warmed^b (*Henson, 2006*)
- More precipitation is falling in short intense bursts rather than spread over a number of days. This increases the risks of flash flooding and soil erosion
- Figure 1.0 shows that Global and Central England temperature anomalies (deviation from the norm) have risen over time with a fairly continuous warming since the 1980's.

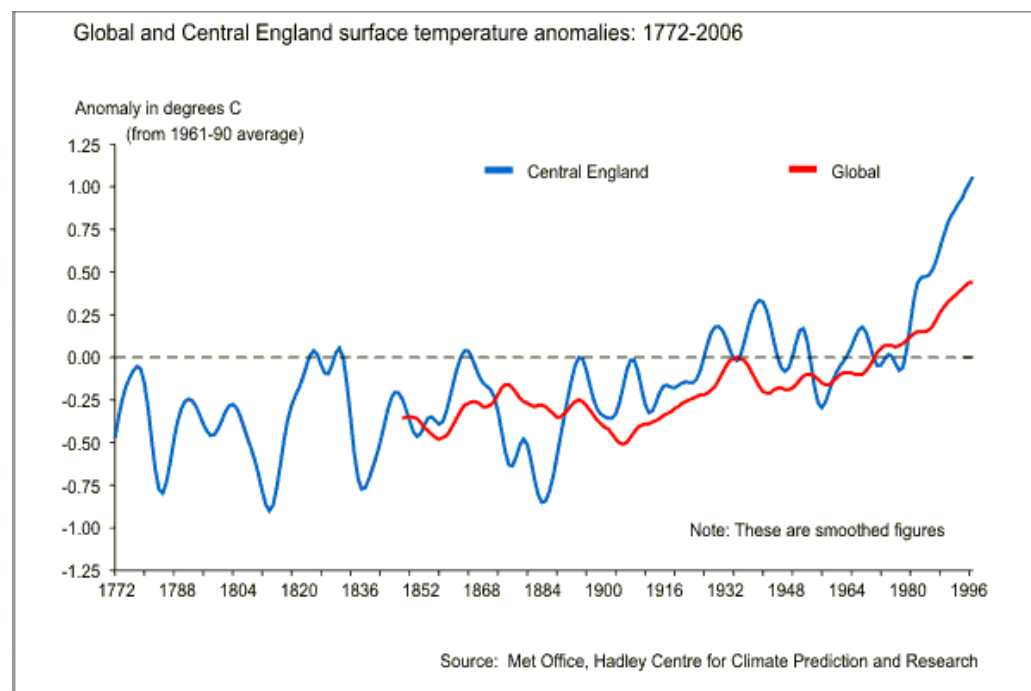


Figure 1.0: Global and Central England temperature anomalies from 1772- 1996 (DEFRA, 2007)

^a Ocean circulation changes within the Pacific Ocean as part of the El Nino Southern Oscillation (ENSO) influences the Walker atmospheric circulation cell over the Equatorial Pacific, thus determining different weather patterns.

^b Many animal species have different comfort temperatures in which they live so as temperatures change, the species will move to live in the appropriate climate for them

1.3.3 Defining Severe and Extreme Weather

Severe weather relates to weather which lies outside the normal intensity for that particular locale. While some severe weather events are particularly destructive in nature, not all will end in disaster. It may be necessary to distinguish between the terms 'severe' and 'extreme' as events that have difference recurrence intervals. Table 1.1 highlights the type of severe weather we can expect in Worcestershire at present.

Table 1.1. Table to show types of severe weather that could be expected in Worcestershire

Type of weather event
Heavy rainfall
Heavy rainfall leading to flooding
Prolonged high temperatures
Lack of rainfall leading to drought
Heavy snow or ice
Thunderstorms
Gales/storms
Dense fog patches

Location is a very important factor when considering severe weather events. While some areas of the UK may consider a few centimetres of rainfall in a day is a lot, areas of Scotland or Wales may see it as nothing unusual.

The [West Mercia Local Resilience Forum](#) has begun to prepare for such extreme weather events through assessing the risk they pose to the area. All weather risks have been given a high risk rating with the exception of low temperatures and heavy snow which was rated as very high risk due to the high likelihood of occurrence and potential level of impact.

Events such as flash flooding usually require a number of factors other than a single precipitation episode. Ground conditions and previous weather conditions are also important. With regards to heatwaves, the population will be affected in different ways. Risk groups such as the elderly (75 years +) and young children, and people already weakened by illness will be most affected by excessive high temperatures. People living and working in dense urban areas will feel more of the heatwave effects than rural communities. The amount of atmospheric pollution plays a significant role in the impacts on health during heat waves^c.

As the climate of the UK changes, it is predicted that the intensity and frequency of extreme events will increase, thus creating difficulties in the everyday running of services.

^c Pollution generally becomes worse during heat waves as concentrations are increased near the surface. This was shown during the 2003 heat wave in the City of Paris, France.

2.0 Impacts of severe weather on Worcestershire

Between 1997 and 2010, Worcestershire has been influenced by a number of weather events ranging from flash flooding and storms to severe heat and snow and ice. To obtain information about how such events have impacted on the county in previous years, a media trawl of local newspapers was carried out. Information gained from these newspapers is shown in table 2.0.

Some of the weather events appear to have been very localised i.e. lightning strike in one district or one road affected by a flash flooding event, while others affected a much larger area of the county.

It is important to note that the media is not considered by any means a complete source of information for weather events and impacts in Worcestershire.

It was deemed that if a story about weather conditions was reported in local newspapers then it was a significant weather event. Further information was obtained through interviewing staff. The interview questions are displayed in appendix 1.

Incidents such as flooding appear to have more coverage. Only storms and lightning phenomenon that caused damage were found in this selection.

The research highlighted that nearly half (49%) of all weather events to have affected Worcestershire were linked to heavy rainfall/flooding. The second most common type of severe weather recorded was snow/ice (18%). Prior to 2009 this had been recorded at heatwaves.

Table 2.0 highlights the date the story was printed (exact event dates could not be obtained for all incidences), the type of events discussed e.g. flood, drought, snow etc. The locations affected by the phenomenon and the impacts discussed in the article are also outlined. The shading signifies the same event reported in more than one article. This helps to identify the scale of each event.

Table 2.1 shows the same date, event and location detail as table 2.0 but also indicates the sectors and services that were affected by the occurrence. The shading selections are used in both tables for ease of comparison between the two data tables.

Table 2.0: Severe weather impacts across Worcestershire 1997-2007 from local media sources. Highlighting the date the story was printed, the type of event, locations affected and details about specific impacts.

(Sources: Malvern Gazette, Kidderminster Shuttle, Evesham Journal, Worcester News, Bromsgrove Advertiser and Redditch Advertiser, 1997-2007.)

Date of story	Event	Location	Notes and comments
16/04/1997	Grass Fire	Lickey hills, Bromsgrove	Grass fire
28/05/1997	Drought	Bromsgrove	Low water levels, threat to flora and fauna, driest 2 year period for 200 years
02/07/1997	Heavy downpours	Bromsgrove	Flattened cereal crops, sales of products such as sun cream dropped
07/01/1998	Floods	Worcester	Roads closed, homes damaged, Worcester Cricket Club and Worcester Race Course under water, 1 in 5 year event
07/01/1998	Floods	Upton-upon-Severn	Sandbags and warnings too late, Swan Hotel closed
08/01/1998	Floods	Diglis Avenue , Worcester	24 homes affected by flooding, 2" water ground floor. 1 in 2.5 year event (EA). Plans to raise floor to reduce flood risk to 1 in 50years
08/01/1998	Floods	Wyre Forest	1000 sandbags from Wyre Forest District Council, River 13ft above usual level
09/01/1998	Floods	Hylton Road, Worcester	Closure of Hylton Road caused traffic jam on Henwick Road, cars stopped on level crossing, trains still functioning
16/04/1998	Floods	Broadway, Evesham	17ft 2" flood levels in some areas, 3-3.5" rainfall in 24 hrs, 100 people rescued. 1 week after new Worcestershire County Council launch
16/04/1998	Floods	Weir Meadow Holiday Park, Evesham	Turned away approx1000 holiday makers, 100 caravans damaged
16/04/1998	Floods	Bengeworth First School, Evesham	Flooded by 5ft water, damaged computers, TVs, filing cabinets, work, carpets. Delayed return to school
16/04/1998	Floods	Evesham	Park View Hotel and Northwick hotel expected closure 3months, guests cancelled, 6ft depth at Northwick Hotel. 1 in 40 year event.
16/04/1998	Floods	Wyre Piddle	Lower Avon Navigation Trust, 3ft water, records destroyed
16/04/1998	Floods	Worcestershire	Event not classed as an act of God by insurers, keep damaged goods
16/04/1998	Floods	Evesham	Sheep drowned in field or swept away. Not been seen in living memory
14/06/1998	Floods	Evesham,	Damage to caravans and hotels, 34

		Worcester, Bewdley	percent drop in visitors
30/10/1998	Floods	Upton-upon-Severn	Road closures ignored, flooded 90mins after the EA issued red alert 8pm Wednesday. Fields on both sides of Worcester and Powick. 6" water in Plough Inn by
			Thursday morning. Frank Hill, Malvern Gazette '4" rain so far this month and the average for October is 2.5" '
15/01/1999	Floods	Upton-upon-Severn	Flooded last week, 3 weeks after Waterside pub opened after November floods. Water gone down Monday, silt and mud left. EA £1 million programme for improving
			Flood monitoring and prediction. 4th time in 13 months flooded
24/12/1999	Snow/ice	Worcestershire	Gritting stopped at Herefordshire border. After snowfall - 9C. Lowest temperatures for 10yrs (December 18). Main roads priority for gritting. 1 in 10 year event.
28/04/2000	High rainfall	Malvern	Well distributed so reduced flood risk. 5.6" rain fell in a month, first time duration of rainfall recorded greater than sunshine; 122 hrs rain & 98hrs sunshine.
02/10/2000	Flash flooding	Warndon's Burford Close, Worcester	2ft water, 1" rainfall fell in 1hr, Council blames Severn Trent and visa versa, 98mm of rain in Sept, should only be 72mm (most fell at end of month). Worcester City; 'nothing can be done'.
03/11/2000	Floods	Upton-upon-Severn	Evacuated November 2, New Street, water through the floor. Kings Head and Swan Inn flooded (4ft). Summer Cottage (next to Swan), worst since the 60's. 1 in 10 year event.
03/11/2000	Storm	Malvern	Sunday 29 and Monday 30 wettest for 1yr and windiest for 3 yrs. 41mm rain fell in 24hrs. 45+60mph winds. Loosen soil – trees may fall. Worst A438.
		Worcester	A44 west of Worcester power line brought down. Earls Croome - house flooded
09/11/2000	Floods	Bewdley	Town centre closed, 80 homes flooded in first week, 110 people evacuated, 5.56m. Kidderminster on flood watch, downgraded next day (sandbags as precaution),
		Bewdley	1 in 20 year event
	Floods	Bewdley	Bewdley thought to be inaccessible,

			specialist traders boost sales i.e. Sales of waterproofs increased, John Williams-policy officer WCC
09/11/2000	Floods	Lickhill Manor Caravan Park, Stourport	Power supply affected, 40 residents evacuated
09/11/2000	Floods	Stourport Industrial Estate	4ft water, 10 firms on Sandy Lane Industrial Estate flooded
10/11/2000	Floods	Upton-upon-Severn	East Waterside no warning. 3-4ft water. Worse than 1947. Flood defence breached. Protecting agricultural land making problems in town worse. Stops flooding of
	Floods	Upton-upon-Severn	natural floodplain.
10/11/2000	Floods	Bewdley	Hanley Road closed, evacuation and sandbags. Not same movement of waters as previous week. Worcester river bridge open Saturday afternoon-traffic in Powick
		Bewdley	reduced. Wednesday morning delays 1 1/2 hrs. Road subsidence between the Upton/Ryall junction and the Ketch on the A38. Ignored road closure signs.
10/11/2000	Floods	Upton-upon-Severn	Upton CE Primary School, town road bridge impassable to cars, children taken to school by tractors and taken home in army trucks. Not all houses flooded. Roads affected
10/11/2000	Floods	Upton-upon-Severn	Madresfields Pre-school centre Monday, children taken in wheelbarrows. 6" deep flooding. Drainage problem at trading estate around Safeway.
		Upton-upon-Severn	Only a problem in last 2 yrs?
		Upton-upon-Severn	Mike Davis - Highways Partnership ' It was essentially a land drainage problem but the flood water was getting into the foul drain.'?
10/11/2000	Floods	Upton-upon-Severn	Flood water highest since 1947. Maize lost for 3rd yr running. 130 acres of 145 acre farm under 9ft water. Ryall road flooded, 5ft deep near river. 2 months rain. Though to be a 1 in 53 year event.
10/11/2000	Floods	Malvern	5 1/2" rainfall in last 2 weeks. 1 1/2" (38mm) fell in 24 hrs in Malvern on Monday
		Malvern	Hotels benefit from people being evacuated. No one from outside came to stay during that time
16/11/2000	Floods	Bewdley	Complaint that flooding signs misleading and damaged businesses. Mrs Barton's

			clothes shop 80 percent down on business
01/12/2000	Floods	Upton-upon-Severn	New Street and Waterside. Clive's hairdressers, New Street- pump running 4 weeks to keep water out cellar. People evacuated. River Severn rising slowly, not expected to reach previous levels. 1 in 50 year event.
08/12/2000	Floods	Upton-upon-Severn	Hanley Road closed. Kings Head flooded while landlord at meeting discussing previous floods. Riverside properties 2inches water. A4103 and B4211 closed.
		Upton-upon-Severn	Beauchamp Lane, Callow End- sewage in flood water. WCC+ Malvern DC held meeting, Cllr Bob Bullock. County Hall 12/12/2000
29/12/2000	Snow fall	Worcestershire	WCC decide whether to grit. Main roads passable with care. £10 000 to grit whole county in 3 hrs
13/07/2001	lightning	Malvern	Broadlands Drive, house struck by lightning- 6ft hole in the roof. Obliterated TV aerial, rose bush and phone. Albert Road- Computer system affected
10/08/2001	Floods	Great Malvern	Lydes Road near Great Malvern Primary School. Sewers overflow. Flows across playground. No comment from Council. Severn Trent say Council responsibility
04/10/2001	drought	Malvern	Since August 1995. Driest September since 1986. 30 hrs more sunshine than normal- total of 160 hrs of sunshine
01/11/2002	Gales	Tarrington, Herefordshire border	Cockerel weathervane at St Philip and St James' Church fell off
01/11/2002	Gales	Malvern	Disrupted water supply due to power cut at pumping station (Sunday 27th). Winds 87mph (strongest since December 1993)
01/11/2002	Gales	Malvern	Power cut affected Malvern Lifeline System. 7000 people rely on it, 18 hr battery life. Off from Sunday morning until the 2nd 1/2 of the week in some regions
01/11/2002	Gales	Malvern	Trees blown across roads. A449 Malvern to Ledbury affected. Foley Terrace, Victoria Road car park and Imperial Road. 70 incidents reported - Mike Davis WCC Highways
		Malvern	Advice -be aware what is above you.
01/11/2002	Gales	Malvern	Chimney fell through roof, Manby Road. Roof, floor and wall damage (October

			27). 1 in 25 year event
13/12/2002	Snow fall	Malvern	Snow on the morning of the 12th made driving conditions difficult. Church Street
03/01/2003	Flash floods	Malvern	Road problems 02/03/2003. 6-7am 10-15mm rain. B4210, A449. Flood warning on River Severn.
27/03/2003	Grass Fires	Kidderminster Riffle Range Estate	200 sq m grass caught fire in Tolley Road. Fire Chiefs warn public
27/03/2003	Grass Fires	Malvern Hills	5 hectares. 75 fire-fighters from across Worcestershire brought it under control in 3 hrs. Saturday 22nd March
03/04/2003	Grass Fires	Burlish Top Nature Reserve, Kidderminster	14 outdoor blazes. Flame above 25ft trees. Springfield Park suffered March
29/05/2003	Floods	Bewdley	5ft above normal height. Mother and 4yr old son saved from drowning
30/05/2003	Heat wave	Worcester	No water in the paddling pool at Worcester's Gheluvelt Park due to Worcester City Council cut backs not able to afford enough attendants.
17/06/2003	Undergrowth fire	Stourport Road, Kidderminster	2 fire crews, 4hrs to bring blaze under control. Not the only fire that week. Near Brintons factory
17/07/2003	Heat wave	Vale of Evesham	Vale of Evesham saw highest temperatures since 1990's- peak 36.4°C. Risk of flash flooding. Pershore 2 days with no water. Dropping river level and possible irrigation problems
18/07/2003	Heat wave	Worcester	Worcestershire Royal Infirmary- temperatures greater than 30°C, possible risk of infection as lack of ventilation. Complaints from patients and relatives. Personal fans used.
06/08/2003	Heat wave	Bewdley and Malvern	West Midlands Safari Park- Giraffes given fruit salad and lollipops to cope with the heat. Temperature in Malvern peaked at 32-34°C
06/08/2003	Heat wave	Worcester	Rescue from the River Severn after a man on a bike fell in. Rescues prior to this one. Warnings issued about swimming in watercourses.
07/08/2003	Heat wave	Worcester	Workers try to keep cool. Take extra breaks and drink plenty. Golden Gourmet fish and chip shop reached 38°C
11/08/2003	Heat wave	Worcestershire	Weather brought visitors to the County. 400 people a day in Worcester High Street enquiring about activities and accommodation. Severn Valley Railway and Malvern Hills Hotel Busy
11/08/2003	Heat wave	Worcestershire	Since start of June, Worcester Tourism Centre has dealt with 4,500 enquiries

			and assisted more than 800 overseas visitors.
14/08/2003	Heat wave	Worcestershire	Weather drew thousands of visitors to the Vale of Evesham and Cotswolds. All guesthouses in Evesham were full. Numbers of foreign visitors in North Cotswolds increased. Broadway very busy.
14/08/2003	Heat wave	Severn Valley Railway, Bewdley	Increase of 5,000 visitors compared to last year. No adverse affects on service due to temperature. Signalling equipment briefly affected but not on the scale of national railway.
28/08/2003	Heat wave	Worcester	WH Smiths- profits £4million lower than previous year, shares fell 7 percent, shoppers stay away from high street. 3 months leading up to June, Marconi telecom had operating losses of £43million
30/01/2004	Snow fall	Malvern	Snow on afternoon of January 28. Power cuts (1/2 hr in Malvern Link), school closures. 45mph gust wind and snow. Martley Primary, Longdon St Mary's closed Thurs.
30/01/2004	Snow fall	Malvern	Somers Park Primary still open. 1-3 cm, 2-3 cm on Hills. Car hit lamp post in Alber Road North on Thurs
19/03/2004	Snow fall	Malvern	Many schools closed. Somers Park Primary still open, They only close in extreme conditions. 3-6" of snow fell
19/03/2004	Snow fall	Malvern and Upton-upon-Severn	Increase in road accidents, 9 on March 12 (day of snow fall), 1 the day before and 4 the day after. In Malvern, Pound Bank Road, Croft Bank and A449 in Malvern Wells
			affected. A4104 Welland to Upton Road, A4103 at Leigh Sinton
09/07/2004	Storm	Great Malvern	Pavement of Church Street closed- tiles off roof. High winds 07/07/2004, highways authority called out. 3400 houses affected by power cut. 08/07/2004 216 houses
			still no power at noon.
13/08/2004	Flash flood	Malvern	Shops affected. 5th August Malvern was wettest place in Britain. 1" rain in an hour. Barnards Greens drains overflowed- an hour to recede
18/08/2004	Flash flood	Bromsgrove	Lower part of high street became a river, Advertiser reception flooded. Morton Fisher Solicitors 3ft water damage. Home in Humphrey Avenue, Charford struck by

			Lightning. Lightning damage West Mercia non-emergency phone line. 108mm rain (not confirmed). Part of A38 flooded, diverted. Start 3pm, receded 6.30pm
24/08/2004	Waterlogged ground	Worcestershire	Story from a County farm. 80 acres of water logged ground. Crops not drying out to be harvested (Wheat and oilseed rape). Land more suitable for cider apples
26/08/2004	Flooding/sewage	Harvington, near Evesham	15min downpour overwhelmed sewage and storm drains. Land drainage problems. Severn Trent+WCC work together. Land drainage WCC problem. Highways
			Maintenance Manager Andy Broome said responsible for highways drainage not fields
01/07/2005	Lightning	Malvern	Priory Park Tuesday evening 70ft tree struck (1 in 30 year event) but safe. Malvern Girls College boarding house and Oxfam, Church Street - alarm malfunctions.
01/07/2005	Lightning	Malvern	Gym at Splash-power cut
24/06/2005	Lightning+ risk of flooding	Stoke Heath & Bromsgrove	House hit by lightning in Stoke Heath, water on roads. Risk of flooding after the long dry spell
14/07/2005	Heat wave	Worcestershire	30°C. Homebase, Hylton Road sold air conditioning units, most popular is most expensive £150. Increased stock 10 fold so not caught out
27/10/2005	Heat wave	Worcestershire	Unusual October heat wave 20°C. Paul Damari "Certainly in my 40 years of working in the area it was the hottest late October day". Following days 16-18°C.
27/10/2005	Heat wave	Worcestershire	(above average). 1 in 40 year event
30/10/2005	Prolonged wet weather	Worcestershire	Merevale Farm, Hanley Castle "So far we have harvested only 50 acres of wheat and have 500 more and 120 acres of beans still to combine." Need 10 days dry
30/10/2005	Prolonged wet weather	Worcestershire	weather. NFU trying to get assistance for most seriously affected.
30/12/2005	Cold conditions/ice	Worcestershire	-8°C, frosts and ice. 1 in 5 year event.
18/05/2006	Lightning and flooding	Evesham/ Pershore	13th May 10 homes Drakes Broughton struck by lightning, damaged roofs, TV aerials, phone masts. 8 homes Church Row, Pershore flooded. Flooding on 12th May Chadbury Road
18/05/2006	Lightning and flooding	Evesham/Pershore	Telegraph pole alight. Power sockets blown, computers overloaded- power

			surge. Croome Close, Huntsman Close, Coachman Close, Shrubbery Road. Chimneys
18/05/2006	Lightning and flooding	Evesham/Pershore	down, holes in roofs. No fires or injuries. 12th Weston Subedge electrical blackout then brownout (insufficient voltage for appliances)
05/07/2006	heat wave	Worcester	32.4°C in Worcester, hotter than Canary Islands and Rio de Janeiro. Homebase, Blackpole Road sold 2000 fans in a day. BBQ related products 4 times higher than normal. Bennett's of Lower Wick ice cream sales doubled in few days. South Worcestershire Primary Care Trust-health warnings
06/07/2006	heat wave	Evesham	Cold, wet towels on sheep head to keep cool. WCC issued flash flood warning, their responsibility for clearing drains
07/07/2006	Flash floods	Worcester	Half month's rainfall fell in 30 mins (23.4mm). Homes Carlisle Road and Canterbury flooded with sewage and water. Drain covers forced off. Crown Court cells
07/07/2006	Flash floods	Worcester	flooded. Businesses not trading, stock damage. Blessed Edward Oldcorne RC High School struck by lightning in Wednesday storms (damaged phones). Worst
07/07/2006	Flash floods	Worcester	affected Bath Road, London Road, Sidbury, Wyld's Lane, Upper Tything, Barbourne, Tolladine, Warndon and Ronkswood
10/07/2006	heat wave	Worcestershire	WCC advising elderly to drink 2 litres water per day. Increased number of heat related emergencies. Safari park, Bewdley, shower elephants
18/07/2006	heat wave	Worcester	34°C (93°F), hotter than Ibiza. Hottest day of the year. May end in flash flooding
20/07/2006	heat wave	Worcestershire	Worcester 34.5°C, Pershore 34.6°C, Malvern 33.4°C, Hereford 34°C. B4202 melting (sand to soak up bitumen), warning signs in place. Mike Davis WCC Highways
			Partnership "We think we may have a problem with the Bitumen at that location and we're looking to a longer term solution when the temperature drops."
26/07/2006	Undergrowth fire	Malvern Hills	35 fire-fighters. Covered 600m in a few minutes. Praised for rapid response

31/07/2006	Severe summer heat	Redditch-Birmingham train line	Railway track buckled at Bourneville (Birmingham). Children from Birchensale Middle School stranded. Central trains staff unhelpful, no bus, requested water - given a bucket. Same problem at Longbridge. Central Trains "The reason for the delay was that two trains had to be turned back because of the heat."
24/01/2007	Storm force winds	Catshill Road, Bromsgrove	Tree (with preservation order) came down onto the road. Dealt with by Highways Authority in 4 1/2hrs. Bromsgrove DC reporting damage while out (refuse collectors)
08/02/2007	Snow	Worcestershire	Schools closed, traffic problems
Jun-07	Floods	Northwest Worcestershire	Public footpaths, bridleways, damage to river banks and structures (bridges). 47 individual locations suffered significant damage. 27 footpaths closed
19/06/2007	heavy, persistent rain	Bromsgrove	Carnival- 84 stalls signed up, 18 turned up. Health and safety issues with fairground rides. Organiser Gary Walmsley
03/07/2007	Floods	Tenbury Wells	early hrs Tuesday morning. 3 race meetings cancelled Pitchcroft. Wettest June on record. Attractions and events loss in numbers, events cancelled. Cricket ~£200,000
03/07/2007	Floods	Worcester	Elgar festival takings not badly affected. Severn Leisure Cruises not operating due to river levels. Cathedral ferry lost ~£400 takings
03/07/2007	Floods	Worcester	River Teme and Severn flooding.
04/07/2007	Heavy rain	Arley (Bewdley)-Bridgnorth (Shropshire) railway	Downpours 19th June. Severn Valley Railway Tracks damaged. Land slips at 45 locations. 9 locations need machinery. £500,000 damages
09/07/2007	Flash flooding	Worcester, Tenbury Wells	2 months rain fell in 24 hrs.. Began June 24. 28.5mm fell in Worcester, west Worcestershire +40mm. 50 000 properties power cut. June 25 Tenbury Wells town centre.
09/07/2007	Flash flooding	Tenbury Wells	Most intense rainfall for 50 years, flooded (River Rea+Teme)
09/07/2007	Flash flooding	Worcester	Homes & businesses under ~1ft water, June 26 continued rise affect roads & homes. New Road Cricket Ground cancelled match. June 27more
09/07/2007	Flash flooding	Powick and Pershore	areas affected. Powick- 30 people rescued. Judge Eric Dickson died in Pershore Flood (car swept away). Destruction for farmers, homeowners+ businesses

18/07/2007	Flash Flooding	Tenbury Wells	3ft water. 15mm in 1 hr. Public toilets in Market street collapsed (recently refurbished) £33,650 cost, 4ft mud block slid into Kyre Brook, 13ft stretch adjoining wall collapsed.
20/07/2007	Flash Flooding	Malvern	Cut off on the afternoon of July 20. Primary schools closed at lunchtime. A449 flooded. St. Saviours Surgery affected. Leigh Sinton Road impassable
20/07/2007	Flash flooding	Evesham	Vale of Evesham School (special needs)-children trapped, had to stay over night. Schools closed early. Road at Crophorne collapsed. Bridges closed to traffic-
20/07/2007	Flash flooding	Evesham	Debris damaging structures. Bengeworth First school flooded-mobile classrooms needed replacing. Homes around Bengeworth evacuated. Rest centre set up
20/07/2007		Evesham	at leisure centre. Sea King helicopter for rescues, Sedgeberrow. Market garden at Offenham flooded. Caravans flooded and evacuated. Water waist deep in places.
20/07/2007		Evesham	Hampton cut off from Evesham. DeMontford Medical Centre flooded and closed, used Evesham Community Hospital instead.
20/07/2007		Tenbury Wells	Not recovered from flooding the week before. Regal Cinema flooded, Teme Street flooded. Houses flooded with water and debris. Building and pavement subsidence
20/07/2007		Tenbury Wells	Hygiene warning due to contaminated water. Warnings on River Teme, Onny and Corve and their tributaries
20/07/2007		Upton-upon-Severn	Cut off from the rest of Worcestershire. No new flood barriers unlike other areas. Major bridge closed. Rest centres. Peaked at 6.06m. Starting to recede 4 days
20/07/2007			later. Flood barriers were 30 miles away when flooded, water would have topped them. Caravans floated away. Army helped provide supplies.
20/07/2007		Worcester	4-6" contaminated water in Hylton Road, £30,000 damage at homes, 6-7 months before habitable. Flood defences not in place. Racecourse and cricket ground

20/07/2007		Worcester	flooded. River bridge closed, only four routes in and out of Worcester. A38 and A449 blocked, people stranded on M5. Cherry Orchard Primary School- children rescued by the fire service. Thornton House School (special needs)- Children stayed over night. Safety of roads checked before re-opened
20/07/2007		Bromsgrove	Spadesbourne Brook burst its banks. Inch of water in Brook Road, Millfield Road, Ford Road and St Peters Close. Two key roads in and out-M5 and A38
20/07/2007		Bromsgrove	(Problems later on M5). Fallen tree on Old Birmingham Road. Roads flooded- Stonely Lane, Lilley Green Road, Redditch to Boardsley Road, all at Alvechurch and Holt End and Beoley
20/07/2007		Redditch	Brockhill and Batchley flooded, Winsor Road- manhole covers lifted and flooded car parks. Washford Mill road flooded- fire service in attendance. River Arrow burst
20/07/2007		Redditch	banks and flooded car parks and footpaths near Arrow Valley Lake- Raised lake level. Flooding at Matchborough allotments. Ipsley CE Middle school sent home
20/07/2007		Redditch	early to avoid problems on roads, Matchborough Way and Winyates Way impassable, underpasses also affected. A4189 between Redditch and Henley badly
20/07/2007		Redditch	affected. Accident on Redditch Highway in the morning. Flooding near the Abbey Stadium. Woodberrow Road- manhole covers lifted.
20/07/2007		Droitwich	High Street under 15 ft water. Businesses flooded, most animals at pet shop died. Worcester Road blocked. Rest centre at Spa's Heritage Centre. River Salwarpe
20/07/2007			burst banks. Gardens flooded in Vines Lane. First time Droitwich canal basin flooded.
20/07/2007		Pershore	Helicopter rescue and rescue boats. Homes and cars flooded. Football pitch flooded. Canoe and Kayaks on water
20/07/2007		Wyre Forest	Blake Brooke in Kidderminster affected by a fallen tree. Road between Great Whitley and Holt Fleet affected by a fallen tree. Two members of the Fire

			service cut
20/07/2007		Wyre Forest, Malvern, Droitwich	off by rapidly rising waters and rescued by member of the public in 4x4. Fire Service dealt with situations as they arose. High volume pumping equipment sent to Malvern (July 20) and Droitwich High Street after that .
20/07/2007		Wyre Forest, Worcester	River Stour and nearby brook burst their banks leading to flooding at Blakeshall Lane Wolverly. A449 traffic problems in afternoon. Stourport Mill Road and B4194 remained closed on the July 23.

Table 2.1 : Severe weather impacts across Worcestershire 1997-2007 from local media sources. Highlighting the date the story was printed, the type of event, locations affected and the affected services

(Sources: Malvern Gazette, Worcester News, Evesham Journal, Bromsgrove Advertiser, Kidderminster Shuttle, Redditch Advertiser, 1997-2007)

Date of story	Event	Location	Affected Organisation/Sector
16/04/1997	Grass Fire	Lickey Hills, Bromsgrove	Worcestershire County Council (WCC) & District Emergency Planning/ H&W Fire and Rescue
28/05/1997	Drought	Bromsgrove	Biodiversity and Environment Agency
02/07/1997	Heavy downpours	Bromsgrove	Agriculture
07/01/1998	Floods	Worcester	WCC Highways and Transport and Environment Agency
07/01/1998	Floods	Upton-upon-Severn	Tourism businesses
08/01/1998	Floods	Diglis Avenue , Worcester	Worcester City Council
09/01/1998	Floods	Hylton Road, Worcester	WCC highways and transport
16/04/1998	Floods	Broadway, Evesham	WCC & District Emergency Planning and Environment Agency
16/04/1998	Floods	Wier Meadow Holiday Park, Evesham	Tourism sector
16/04/1998	Floods	Bengeworth First School	WCC Children's Services
16/04/1998	Floods	Evesham	Tourism businesses
16/04/1998	Floods	Wyre Piddle	Lower Avon Navigational Trust
16/04/1998	Floods	Worcestershire	Insurance sector
16/04/1998	Floods	Evesham	Agriculture (DEFRA)
14/06/1998	Floods	Evesham, Worcester, Bewdley	Tourism
30/10/1998	Floods	Upton-upon-Severn	WCC Highways and Transport Agriculture and Environment agency
15/01/1999	Floods	Upton-upon-Severn	Tourism businesses Environment Agency
24/12/1999	Snow/ice	Worcestershire	WCC highways and transport
28/04/2000	High rainfall	Malvern	Environment Agency
02/10/2000	Flash flooding	Warndon's Burford Close, Worcester	Worcester City Council
03/11/2000	Floods	Upton-upon-Severn	Tourism businesses and WCC & District Emergency Planning
03/11/2000	Storm	Malvern	WCC Highways and Transport and Electricity provider
09/11/2000	Floods	Bewdley	WCC Highways and Transport and WCC & District Emergency Planning,

			Businesses
09/11/2000	Floods	Lickhill Manor Caravan Park, Stourport	WCC Emergency Planning
09/11/2000	Floods	Stourport Industrial Estate	Businesses and Wyre Forest DC Environmental Health
10/11/2000	Floods	Upton-upon-Severn	Environment Agency and WCC & District Emergency Planning
10/11/2000	Floods	Bewdley	WCC Highways and Transport and Wyre Forest District Council
			WCC & District Emergency Planning
10/11/2000	Floods	Upton-upon-Severn	WCC Children's Services and Highways and Transport
10/11/2000	Floods	Upton-upon-Severn	WCC Children's Services and Highways and Transport
10/11/2000	Floods	Upton-upon-Severn	Agriculture and WCC Highways and Transport
10/11/2000	Floods	Malvern	Tourism
16/11/2000	Floods	Bewdley	Businesses and WCC Highways and Transport
01/12/2000	Floods	Upton-upon-Severn	Businesses and WCC & District Emergency Planning
08/12/2000	Floods	Upton-upon-Severn	WCC Highways and Transport and businesses
			Wyre Forest DC Environmental Health
29/12/2000	Snow fall	Worcestershire	WCC Highways and Transport and businesses
13/07/2001	lightening	Malvern	Malvern Hills District Council
10/08/2001	Floods	Great Malvern	WCC Children's Services, WCC Highways and Transport and Malvern Hills District Council
04/10/2001	drought	Malvern	Environment Agency
01/11/2002	Gales	Tarrington, (Herefordshire border)	District Council
01/11/2002	Gales	Malvern	WCC & District Emergency Planning, electricity and water provider
01/11/2002	Gales	Malvern	WCC Adult and Community services
01/11/2002	Gales	Malvern	WCC Highways and Transport
01/11/2002	Gales	Malvern	Malvern Hills District Council
13/12/2002	Snow fall	Malvern	WCC Highways and Transport
03/01/2003	Flash floods	Malvern	WCC Highways & Emergency Planning and Environment Agency
27/03/2003	Grass Fires	Kidderminster Riffle Range Estate	H&W Fire and Rescue Service
27/03/2003	Grass Fires	Malvern Hills	H&W Fire and Rescue Service, Tourism and WCC Countryside Services
03/04/2003	Grass Fires	Burlish Top Nature Reserve, Kidderminster	H&W Fire and Rescue Service, Tourism and WCC Countryside Services
29/05/2003	Floods	Bewdley	WCC & District Emergency Planning and H&W Fire and Rescue Service

17/06/2003	Undergrowth fire	Stourport Road, Kidderminster	H&W Fire and Rescue Service
17/07/2003	Heat wave	Vale of Evesham	Agriculture, Severn Trent Water
18/07/2003	Heat wave	Worcester	NHS
06/08/2003	Heat wave	Bewdley and Malvern	Tourism
06/08/2003	Heat wave	Worcester	H&W Fire and Rescue Service
07/08/2003	Heat wave	Worcester	Businesses
11/08/2003	Heat wave	Worcestershire	Tourism
14/08/2003	Heat wave	Worcestershire	Tourism
14/08/2007	Heat wave	Severn Valley Railway, Bewdley	Tourism
28/08/2003	Heat wave	Worcester	Businesses
30/01/2004	Snow fall	Malvern	WCC Children's Services, WCC Highways and Transport and power supplier
19/03/2004	Snow fall	Malvern	WCC Children's Services, WCC Highways and Transport
19/03/2004	Snow fall	Malvern and Upton-upon-Severn	WCC Highways and Transport
09/07/2004	Storm	Great Malvern	WCC Highways and Transport and power supplier
13/08/2004	Flash flood	Malvern	Malvern Hills District Council and WCC Highways
18/08/2004	Flash flood	Bromsgrove	WCC highways and transport and businesses
24/08/2004	Waterlogged ground	Worcestershire	Agriculture
26/08/2004	Flooding/sewage	Harvington, near Evesham	WCC Highways and transport (responsibility for field drainage unclear).
01/07/2005	Lightning	Malvern	WCC emergency planning and MH District Council
24/06/2005	Lightning+ risk flooding	Stoke Heath & Bromsgrove	WCC /district Emergency Planning and Environment Agency
14/07/2005	Heatwave	Worcestershire	WCC & districts emergency planning and businesses
27/10/2005	Heatwave	Worcestershire	Possibly agriculture (unusually warm for time of year)
30/10/2005	Prolonged wet weather	Worcestershire	Agriculture, DEFRA, NFU
30/12/2005	Cold conditions/ ice	Worcestershire	WCC Highways and Transport
18/05/2006	Lightening and flooding	Evesham/ Pershore	H&W Fire and Rescue Service, Wychavon District Council and electricity supplier
05/07/2006	Heatwave	Worcester	WCC & district emergency planning, businesses, NHS and City Council staff
06/07/2006	Heatwave	Evesham	Agriculture
07/07/2006	Flash floods	Worcester	WCC highways and transport, businesses, Crown Court and WCC Children's Services
10/07/2006	Heatwave	Worcestershire	Emergency planning, NHS and animals
18/07/2006	Heatwave	Worcester	Emergency planning

20/07/2006	Heatwave	Worcestershire	Emergency planning, WCC highways and transport
26/07/2006	Undergrowth fire	Malvern Hills	H&W Fire and Rescue Service
31/07/2006	Severe summer heat	Redditch-Birmingham train line	WCC Childrens services, public transport
24/01/2007	Storm force winds	Catshill Road, Bromsgrove	WCC highways and transport and Bromsgrove District Council
08/02/2007	Snow	Worcestershire	Children's Services and WCC highways and transport
Jun-07	Floods	Northwest Worcestershire	WCC Countryside Services, Worcestershire biodiversity and Environment Agency
19/06/2007	Heavy, persistent rain	Bromsgrove	District Council
03/07/2007	Floods	Tenbury Wells	Tourism
	Floods	Worcester	WCC highways
04/07/2007	Heavy rain	Arley (Bewdley)-Bridgenorth (Shropshire)	Tourism and Wyre forest District Council,
09/07/2007	Flash flooding	Worcester, Tenbury Wells	Power supplier, businesses, District Council including Environmental Health
18/07/2007	Flash Flooding	Tenbury Wells	MH District Council including Planning
20/07/2007	Flash Flooding	Malvern	WCC Emergency Planning, highways and transport, Children's Services and MH District Council
		Evesham	WCC Emergency Planning, highways and transport, Children's services, H&W Fire and Rescue Service and Wychavon District Council
		Tenbury Wells	WCC Emergency planning, MH District Council including environmental health and businesses
		Upton-upon-Severn	WCC Emergency Planning, highways and transport, tourism and H&W Fire and Rescue Service
		Worcester	WCC Emergency planning, H&W Fire and Rescue Service, District Council including Environmental health, WCC highways and transport, WCC children's services and Environment Agency
		Bromsgrove	WCC Emergency planning, District Council and WCC Highways and transport,
		Redditch	WCC Emergency planning, highways and transport, District Council
		Droitwich	WCC Emergency planning, Wychavon District Council including environmental health, and businesses
		Pershore	WCC Emergency planning, military assistance for rescues, H&W Fire and Rescue Service and highways and transport

3.0 Impacts of severe weather events on services

3.1 Flooding 1998

Limited information was available for this episode of flooding, as this was the year of the opening of Worcestershire County Council. No records were available and many staff involved have moved jobs.

This flooding was similar to that in 2007 as it occurred from within the Worcestershire catchments. As it was Good Friday, tourists were staying in a number of caravan parks along the floodplain and thus had to be rescued as the caravans began to flood.

Nine weeks worth of rainfall fell in just two days over central England with one of the worst affected areas being Evesham in Worcestershire. In Pershore, 80mm of rain fell in just 24 hours. Flood warnings were issued for the River Severn and the River Avon, these rivers flooded. At the time, the 1998 flood was the highest recorded for Evesham and was said to be a one in 150 year event. Damage was caused to many properties and a number of cars were abandoned (Saunders, 1998).

3.1.1 Insurance- Worcestershire County Council

For the policy year of April 1 1998- September 28 1998, seven public liability claims were made against Worcestershire County Council as a result of the flooding. A second flood later in the year led to 26 public liability claims for the period of September 28 1998- September 28 1999¹⁷.

3.2 Flooding 2000

Limited information was available for this flooding event even though it had widespread impacts. The flooding did not come from directly inside the Worcestershire catchments so this allowed for monitoring of river levels and time to prepare. Many people were unprepared for the scale of this flooding as a number of homes had not flooded since 1947^d and some may not have been built at that time. This led to a lack of public response with regards to evacuations.¹³

Lessons were learnt and improvements made in preparation for further large flood events.

3.2.1 Insurance- Worcestershire County Council

The total number of public liability claims for flooding in the period covering this event were seven but not payments were made.¹⁷

3.3 Storms 2002-2003

Storms across the county have affected different services over recent years. This resulted in damages to buildings and problems with fallen trees blocking highways.

3.3.1 Insurance- Worcestershire County Council

Between April 1 2002 and March 31 2003 five claims were made for storm damage to school buildings.¹⁷

3.4 Heatwave 2003

The heatwave of 2003 affected many European countries, the UK included. Devastating outcomes were seen across France with a large number of excess deaths recorded as a result of high temperatures. Records were broken in the UK as temperatures in some regions climbed to 38°C. In Worcestershire, temperatures peaked around 32-34°C with little relief at night. The maximum temperature for the West Midlands region was 35°C and did not drop below 29°C (National Statistic, 2007).

^d Wide scale flooding in 1947 as a result of rapid snow melt

The movement of the high-pressure system north from the Azores, positioned high temperatures over England causing many health issues. Worcestershire County Council follows the NHS heatwave plan which is reviewed annually.

3.4.1 Adult and Community Services- Worcestershire County Council

This service is responsible for a number of nursing and residential homes including respite care beds across Worcestershire. This directorate is also responsible for home care services. The Primary Care Trust offers heat related warnings and advice on signs of heat related illnesses.

Following this heatwave, further guidance and advice has been issued generally by the NHS regarding the health impacts of high temperatures.

3.4.2 Agriculture and biodiversity

Drought conditions create problems with regards to agriculture and biodiversity. Problems with irrigation; some crops and grasses may stop growing as a result of the lack of water they receive.

Biodiversity is another area that is affected by drought during heatwaves. When the ground begins to dry, worms and other soil dwelling creatures will move down the soil profile to find damper conditions. This process causes problems for birds as they are unable to access their food deeper under ground.

3.4.3 Hereford and Worcester Fire and Rescue Service

Increased outdoor fire risk is generally linked to predominantly hot, dry conditions. For the period of 2001-2006, this heatwave event has had the largest recorded number of secondary fires (over 1000). This is highlighted by figure 2.1. The extra fires attended put a strain on the resources of the fire service as their workload increased. This may also begin to have implications for their budget (CFOA Operations Committee, 2007).

3.4.4 National Health Service (NHS)

England as a whole saw 17 percent excess deaths during the period from August 4-13 2003. The majority of these were people aged 75 and over. In London hospital admissions for members of the population aged over 75 increased by 16 percent. Pollution concentrations in urban areas were also elevated during this heatwave further adding to health problems especially with asthma sufferers.

In the West Midlands region, ten percent excess deaths were recorded with the majority in the 75+ age category. This is less than the total figure for excess deaths in England. Emergency hospital admission across the county increased by two percent during the heatwave, one percent above the figure for England.

For England, the peak temperature and ozone concentrations occurred on August 9, the following day saw the peak in emergency hospital admissions. Two days after the peak temperatures, the peak numbers of deaths were reached. This shows the possible links between temperature and pollution and the implications for health (National Statistics, unknown)

Looking at previous heatwaves in 1976 and 1995, the excess mortality was greatest in 2003.

As a result of this heatwave, further advice is now provided via the NHS providing guidelines for health impacts of high temperatures and how to notice signs of heat related illnesses.

3.5 Lightning, 2003-2004

Not all lightning events are reported by the media so it is unclear how many of these events have occurred over recent years. The Fire and Rescue Service may have been called to attend to any fires as a result of lightning strikes but it is not clear with the information available.

3.5.1 Insurance-Worcestershire County Council

For the period of September 29 2003- September 28 2004, eight claims for property damage were made as a result of lightning storms.¹⁷

3.6 Snow and Ice 2005-2006

Although the climate projections suggest a move towards milder winters we can still expect to receive snow and should prepare accordingly to keep services operational.

3.6.1 Insurance- Worcestershire County Council

Although the greatest number of public liability claims were not made in this period between 2005 and 2006, the largest total claims figure was produced. Since September 1998, the financial record shows that for six years no payments for claims were made, but payments were made between September 29 2005 and September 28 2006.

3.7 Lightning 2005-2006

The damage during this period to council property appears to be the most costly in the available financial record. The Fire and Rescue Service may have also been affected but this information is not available.

3.7.1 Insurance- Worcestershire County Council

Between the September 29 2005 and September 28 2006 these most costly total claims for property damage from lightning event were made. A total of 7 claims were made.¹⁷

3.8 High summer temperatures, 2006

The summer of 2006 saw temperatures of 34°C across Worcestershire. This not only created uncomfortable working conditions for the majority of people but also had an impact on a number of services, most notably the NHS and the fire and rescue service. These high temperatures were also accompanied by drought. The preceding very dry winter added to the problems of drought. Bans on using hosepipes were put in place across the UK to help conserve water supplies for drinking.

Worcestershire County Council follows the NHS heatwave plan.

3.8.1 Adult and community Services- Worcestershire County Council

As one of the most vulnerable groups to high temperatures are the elderly, especially the 75 years and over bracket, special care needs to be taken in care homes during high temperature. Advice is provided from the Primary Care Trust relating to the heat and to make sure residents drink plenty of fluids. It is possible some people may have to be moved from the care home to hospital if they are not coping well with the temperatures or are not taking enough fluids. Ventilation is also important for care homes to try to keep the buildings as cool as possible for residents.

3.8.2 Agriculture and biodiversity

Many birds are unable to access their food as earthworms move further down the soil profile to find damper conditions in the drying soil. In some areas, wetlands can act as a buffer against heatwaves and the resultant droughts as they store water that can replenish the surrounding drying land.

Agriculture suffers during drought as crops may begin to stop growing or growth may slow due to lack of available water. Irrigation is not always possible as water is in short supply.

The South of Worcestershire is home to the majority of the county agriculture but also happens to be the driest area of the county.

3.8.3 Hereford and Worcester Fire and Rescue Service

Long periods of hot, dry weather generally lead to an increase in the numbers of outdoor fires dealt with across the county. These may be accidental or deliberately set. An extra 916 secondary fires were attended by the fire and rescue service in the second quarter of 2006-2007, this equates to an increase of 63 percent compared with the same period for 2005-2006. The rise in the number of secondary fires is clearly illustrated in figure 3.1, the number of fires attended in 2006 is only exceeded by those of 2003 which was another exceptionally hot summer.

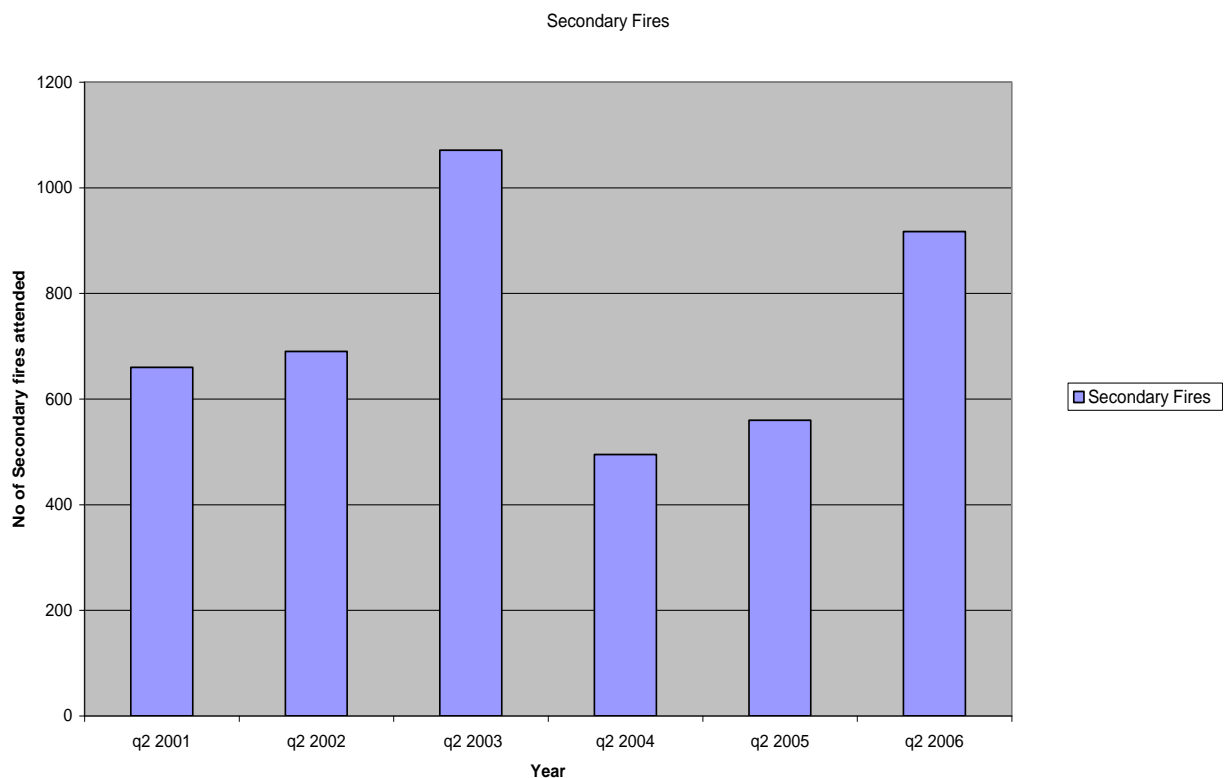


Figure 3.1: The number of secondary fire in the second quarter for 2001-2006 (Hereford and Worcester Fire and Rescue Service, 2007)

It is expected that a 1°C rise in temperature would lead to a rise of 17-28 percent in the number of outdoor fires across England and Wales. If the UK climate was to increase by 2°C, the number of outdoor fires is expected to rise by an extra 40,000-79,000 (34-56 percent) per year. This would put great strain on the Fire and Rescue service and extreme temperatures would be higher than they are with the present climate. With higher extreme temperatures the likelihood of summer fires and drought may also rise (CFOA Operations Committee, 2007)

Droughts pose problems for fire service training as hosepipe bans are enforced.

During heatwaves it is not only fires that are attended by the Fire and Rescue Service. A number of rescues from local watercourses are also necessary. Warnings are issued during hot weather relating to the risks and dangers of cooling off in local rivers and lakes. When

these are ignored and people get in to difficulties the fire service are called to attend. At these incidents, the service may also have to deal with crowds who have gathered to watch.

3.8.4 Highways and Transport- Worcestershire County Council

The unusually high temperatures created problems for the Highways Service as some roads began to melt under the immense heat.

No further information is available at the time of writing.

3.8.5 National Health Service (NHS)

During heat waves the NHS is responsible for offering advice on how the exposure to high temperature may affect a persons health and the possible ways everyone can protect theirself and relatives. An increase in the number of heat related admissions to hospitals usually coincides with prolonged periods of high temperatures. It is also noted that the number of deaths are likely to increase especially in vulnerable groups such as the elderly and unwell. Between July 16 and July 28 2006 a four percent rise in mortality was reported for England and Wales. This equates to an extra 680 deaths compared with the same period 2001-2005 (Department of Health, 2007).

3.9 Lightning 2006-2007

Lightning strikes not only cause damage but also have the potential to initiate fires and cause problems with electrical equipment such as power surges and blackouts.

3.9.1 Hereford and Worcester Fire and Rescue Service

There is the potential for fires as the result of lightning strikes. These will be dealt with by the fire service. Warnings may be provided about how to minimise the risk of fire through unplugging electrical equipment.

3.9.2 Insurance-Worcestershire County Council

During the policy year September 29 2006- September 29 2007 there were two claims for property damage due to lightning strikes. Previous policy years have seen a greater number of more costly claims.¹⁷

3.10 Storms 2006-2007

Storms affect many areas of the county but unfortunately; information about the impacts on services is limited.

3.10.1 Insurance- Worcestershire County Council

By far the most number of claims for storm damage to schools was made between April 1 2006 and March 31 2007 when 11 claims were recorded.¹⁷

3.11 Snow, February 2007

Across the UK the affects of this snowfall were felt by many. Roads were brought to a stand still and a number of cars abandoned as driving conditions were hazardous.

Some schools in the county were closed as some staff were unable to get to the site.

3.11.1 Insurance- Worcestershire County Council

Between September 2006 and September 2007, seven claims were made against the highways department due to snow/ice conditions.

No further information is available regarding the impacts of this event.

3.12 Flooding 2007

The period of May-July 2007 has been noted as the wettest of this period since records began for England and Wales with 387.6mm being documented. In June, an increase of 188 percent from the 1961-1990 average rainfall was marked with 134.5mm falling in one month. In the Midlands this increase was 248 percent from the average with 15 days exceeding 1mm of rainfall.

Following these high amounts of precipitation, the UK rainfall was recorded as being 188 percent above average making 2007 the fourth wettest July on record. The most precipitation was received on the Friday, July 20 with Wychavon, Worcestershire recording 143mm in one day.

These events culminated in widespread pluvial and fluvial flooding across the County. With many areas saturated from the previous months' downpours, a large amount of run off was created overwhelming the storm drainage systems in many districts. Table 2.0 outlines more specific impacts from across Worcestershire.

3.13 Flooding, June 2007

Events in June became over shadowed by the severe weather that unfolded the following month. Well above average rainfall lead to flooding in a number of areas across Worcestershire leaving housing, businesses and infrastructure damaged. Flash flooding affected areas of Wyre Forest while Tenbury and Powick were affected when the River Teme burst its banks (Planning and Economic Regeneration Unit, 2007).

3.13.1 Adult and Community Services- Worcestershire County Council

As with the flooding in July, blocked roads restricted access to certain areas of the county leaving some home carers unable to reach their usual service users
No care homes were flooded during this event.

3.13.2 Agriculture and biodiversity

Farmland situated on the floodplain was inundated on a number of stretches. Crops and grassland were damaged by floodwater and waterlogged soils restricted access to the land. Once the water had receded, farmers could then gain access to begin clearing up debris.

This event caught farmers by surprise as flooding is expected during winter months not in summertime. At Clive's Fruit Farm in Upton-upon-Severn, 350,000 Strawberry plants would have been lost to floodwaters if the raised bed systems were not in place keeping plants above water. Many other farmers were not so lucky and lost acres of wheat, barley and potato crops. As crops are uninsurable, farmers were unable to claim compensation for losses. (Worcester News, 2007).

Flooding also affected the low nesting birds along the river banks by washing away egg clutches and fledglings. Many would have succumbed to the cold, wet conditions unusual for the time of year.

3.13.3 Children's Services and Property Services- Worcestershire County Council

Ten schools were affected by this flooding (table 3.1), nine of these were closed for at least one day as a result. Around 2632 pupils were affected by this flooding.

This flooding did not affect the whole of the county so the impacts were confined to specific areas.

Table 3.1: Schools affected by June 2007 flooding (source- Children's Services)

Upton-upon-Severn primary school was affected but managed to remain open during this flooding.

School	Explanation
Rushwick C.E. Primary	Closed on June 27
Powick C.E. Primary	Closed on June 27
Upton-upon-Severn C.E. Primary	School remained open
Dyson Perrins C.E. High, Malvern	School opened at start of day June 27 but some staff unable to attend so children sent home where possible (Health & Safety) Staff stayed to look after the children who were not able to go home
St. Matthias C.E. Primary, Malvern	Closed on June 27
Madresfield C.E. Primary, Malvern	School closed to Key Stage 1 children on June 27
St. Joseph's Catholic Primary School, Malvern	Closed on June 20 Year 1 children returned on June 21 and Reception children returned on June 27 Reason for closure was water coming off the Malvern Hills (location problems) not because of river floods
St. Anne's First School, Bewdley	School closed on June 20 and 21
Tenbury High School	School closed on June 26 for two reasons: Flooding and the school building was used as an Emergency Refuge Centre
St. Lawrence's C.E. Primary, Lindridge	School closed on June 26

3.13.4 Countryside services- Worcestershire County Council

Across Northwest Worcestershire, countryside sites were affected by flooding. As water levels rose and rivers began to burst their banks, a number of problems were created for public rights of way and bridleways. Overall, 47 locations were affected with 27 footpaths needing to be closed to public access while repairs could be carried out (Worcestershire County Council, 2007). A number of sections of riverbanks and bridges also suffered damage due to the volume and force of the water coupled with debris in the water.

3.13.5 District Councils

A number of district councils were affected by this flooding. Bromsgrove District Council had a decline in the number of stalls (18 out of 84 turned up) that attended their carnival and fair. Some fairground rides could not operate for health and safety reasons.

Issues for environmental health officers were created through clear up of businesses as floodwater may have been contaminated.

Malvern Hills District Council organised evacuation centres for Tenbury Wells residents as many had to leave their homes due to rising waters. These centres required supplies such as blankets and airbeds; all organised and paid for by the local council.

3.13.6 Environment Agency

The Environment Agency is responsible for monitoring river levels, modelling the extent of flood events, issuing flood warnings and erecting and maintaining flood defences across England and Wales. Tenbury Wells was hit unexpectedly by flooding as the River Teme overtopped its banks. When the River began to recede in Worcester, thousands of fish were left on Pitchcroft Racecourse. Workers from the Environment Agency were called out to deal with the problem and save as many fish as possible; inevitably some were lost.

3.13.7 Tourism

The wet weather had begun to deter many people from visiting Worcestershire. The knock-on effects of the weather conditions causing damage to businesses, accommodation and attractions further reduced the tourism economy. Possibly one of the most notable attractions to be damaged was the Severn Valley Railway. Heavy rainfall triggered landslides along the track leaving sections unsupported and others damaged by debris. The Severn Valley Railway is seen as a major attraction for Worcestershire which, by bringing people to the County, supports accommodation and other tourism businesses. With 45 landslips causing damage and the service not fully functioning, other tourism businesses would have also been affected.

River Cruise businesses were unable to operate while river levels were so high. Cathedral Ferry, Worcester also experienced a loss in takings. Severn Leisure Cruises were also not able to run. Not all events had large losses; the takings from the Elgar Festival were not badly affected.

3.13.8 Highways and Transport- Worcestershire County Council

Roads in Tenbury Wells became flooded over night, this created problems with access to homes for residents to be evacuated. Further problems were created in Ludlow after the collapse of a bridge. Highways engineers needed to check the safety of structures before bridges and roads could be fully re opened.

3.14 Flooding, July 2007

The flooding in July 2007 came as a result of intense, persistent rainfall on July 20 that affected the whole of Worcestershire after a period of generally wet weather.

One explanation for the unprecedented flooding is linked to the movement of the 'jet stream'. This phenomenon brings damp, cold air to Northern Europe from the South Atlantic Ocean. For most the summer of 2007 the jet stream was positioned further south than normal. It was also much stronger. Clashing air masses are likely to have been the cause of the heavy rain (The Week, 2007).

The impacts were felt on varying scales, from homes, businesses and roads being flooded in Worcester to the town of Upton-upon-Severn being completely surrounded by water, cut off from the rest of the County. Far more services were affected than during the previous months' flood event due to the sheer scale of the event. Many buildings thought to have

been safe from flooding, such as Bengeworth School in Evesham were damaged by rising waters.

3.14.1 Adult and Community Services- Worcestershire County Council

This flash flooding had a high operational impact upon the services provided by Adult and Community Services. The main impacts were on home care services including meals on wheels. Two care homes were affected and residents were evacuated to other centres around Worcestershire.

Home carers were restricted in their access to service users as roads were blocked and many impassable. This mainly affected residents in the south of the county. The Home Care Service provides advice to home care assistants in the event of severe weather. Communication is important so the locations of all the members of staff were known. An advice pack relating to winter snow also provided guidance for staff during flooding as the impacts are similar. Meals on Wheels services were also affected as the Evesham Kitchen (one of three which prepares the food) was out of action because of floodwater. Staff made sure alternative arrangements were made for the residents who rely on this service.

Timberdine Care Home, Worcester provides respite care for people who require care while family or friends are away on holiday or need a break from care duties. Very few residents live there permanently, many only spend one or two weeks there at a time. Twenty-seven people were evacuated from Timberdine and moved to other care centres. This centre remained closed until the beginning of September 2007. Replacement care had to be found for everyone who was booked to stay there in the following weeks.¹⁸

Tewksbury Nursing Home, Worcestershire also evacuated 25 residents as water came up one inch into the property. As many were unwell and frail, special care needed to be taken to move them out. Two or three of the residents were moved to the community hospital for care. This centre was expected to re open at Christmas 2007, until then residents were being cared for by other homes in the County.

In both cases, repairs or replacement of damaged fixtures and fitting were needed before residents could move back in. Across Worcestershire an additional 20 respite care beds needed to be found as a result of weather events, these were mainly in Wychavon.

Adult and Community Services oversee the evacuation of care homes. The centres themselves claim the damage costs from their insurance policies. Future contingency plans for Home Care services and Meals on Wheels will be looked at in preparation for future severe weather events.

Some costs are being claimed in the Bellwin scheme.¹

3.14.2 Agriculture

Many farmers are now entering in to wetland conservation management. These wetland areas not only help to reduce the impacts of severe weather on the surrounding area but also are beneficial for a number of wildlife species.

It is clear that farm activity on the flood plain of the Severn and the Avon was affected by flooding in July 2007 throughout Worcestershire. It was not only grassland and cattle grazing which were affected but a number of crops were lost. Crops would have rotted or become contaminated by pollution in the water meaning farmers lose out on the money they would have had from the sale of the products. As crops are uninsurable, no lost costs can be claimed back so that source of income is lost. Problems were created where crop was lost but there was still a contract to be met for that produce, forcing farmers to “buy-in” goods for resale. With certain crops in short supply, prices are expected to increase. Not all

farmers will benefit from this if their crops are forward sold (80 percent of grain is forward sold, (NFU, 2007)).⁶

Much of the grass on the floodplain is thought to have been destroyed leaving no hay crop for the farmer and no cattle grazing in the affected fields. Only after two months were cattle starting to return to graze on some of the affected land. It is likely to take two to three years of grass management for the fields to return to their previous state. Problems with weeds etc. are expected to arise. Upton Ham Site of Special Scientific Interest and the neighbouring Buryend Farm were left under a layer of organic material when the floodwaters receded causing damage to the sites and a necessary clean up.²

Farmers who were just entering in to conservation management may have found the aftermath of the flooding a very costly time as they would have adopted a less productive method of farming and would incur huge costs for clear up, reinstating their land and production losses. Many farmers had to clear dead grass, organic matter and debris from their land, which may not have been possible during the first two months after the event. 80-90 percent of this grassland is thought to have died and needed to be cleared. For the next three years many farmers may have had to introduce weed control and extra cutting as well as planting new grass seed to restore the sites.²

With dairy herds being kept indoors due to grazing areas being flooded, winter-feed may have been used earlier than usual leading to a shortage later on. As the cattle were not being fed on grass, there will be a decline in the amount of milk produced so some dairy farmers may not meet demand. Crops requiring dry conditions for harvesting are likely to have been lost if not harvested in time. Many farmers had to work longer hours or take on extra staff to complete all the work as well as clear up debris that was deposited on their land (The Economic impact of the June and July 2007 floods on agriculture in the West Midlands, 2007)

In Offenham, market gardens were damaged by floodwater, not only was produce lost but equipment such as polytunnels was also ruined.

Potato farmers may have to spray their crops more regularly to prevent blight. Tyrrells potato chips crops were also damaged by flood waters.

Further problems arise when using heavy machinery on water-logged ground due to issues of soil compaction. The muddy conditions meant some jobs took twice as long to complete due to the time spent retrieving machinery when it became stuck.⁶

Flooding at Ryall Court Farm near Upton caused a loss of 300 acres of grassland usually used for cattle grazing. Organic farmers across the County that were flooded would have found it very costly to buy in feed for cattle to meet organic status. (Malvern Gazette, 2007). Riverside fields were flooded to varying degrees depending on exact location and the level of protection at each site. Some farms have wetlands to lessen the impact of rising floodwaters while others have small sluice gates installed to control water levels and rates of flow.

A number of farms suffered damage during the July 2007 flooding. Many lost grazing land and crops, which created further problems with sales of produce and the feeding of animals. With the frequency and intensity of severe weather events, such as flooding and drought, expected to increase with climate change, farming practises may have to adapt to minimise the losses from each event.

3.14.3 Biodiversity

Biodiversity along the floodplain was affected. These impacts range from water pollution and excess nutrients causing problems for fish stocks to the loss of egg clutches for nesting birds. Floods do not always negatively affect wetland areas as the systems rely on the influx of water to replenish groundwater.

Sites along the River Severn are believed to have been the worst hit as the water level stayed high for two-three weeks leaving fields starved of oxygen and sunlight. On the River Avon the water level rose extremely quickly (four meters in 30mins) but also receded fairly fast leaving waterlogged soils.²

¹

The summer flooding in 2007 had a two-fold impact on wetland areas. A very low level flood in May that was not picked up on by many people affected the nesting bird populations of Curlew and Lapwing. Both bird species would have been laying eggs during this month. The eggs are likely to have succumbed to the cold, wet conditions and any fledglings may not have survived. Some of the birds may then have relayed egg clutches after the water had receded but were then in the same position of egg loss again in July as a result of more flooding. It is possible that as much as 100 percent of wader bird egg clutches may have been wiped out by the two separate flood events.

Wyre Forest District Council saw the flooding of the wetlands as a positive outcome from the intense July rainfall in 2007. A lack of water over previous years had left wetland areas drier than usual. These habitat areas rely on flooding events so this large event cannot be seen as negative unless further implications are noticed at a later date. Looking more long-term this flooding can be seen to have a positive impact on local wetlands as it replenished the water content.³

The introduction of Sustainable Urban Drainage systems (SUDs) to building developments creates habitats and adds to an area's biodiversity value. These systems not only reduce the likelihood of flooding and the impact of drought by storing and slowly releasing water but also enhance the environment.⁴

Some flooding does occur in the Areas of Outstanding Natural Beauty (AONBs) but it is not as common as in neighbouring areas.⁵

Fish stocks are affected by extremely high and low flows. The July 2007 flooding saw a number of fish stranded on Worcester Racecourse as the floodwaters receded. The Environment Agency was called to rescue as many as possible. The normal pools and lakes became high in organic matter that reduced the oxygen levels leading to the deaths of many more fish. Otters and herons would also be affected as their food supply declined. The loss of a large number of the fish population in the river system ultimately affects the food chain.

An increase in flood events could have a positive influence on wetland areas but is likely to be detrimental for farming economies and low nesting birds.

3.14.4 Worcestershire County Council- Children's Services and Property services

Friday, July 20 was the last day of the school year for many but most schools were forced to close early because of the rain and flash flooding either affecting the school buildings or the surrounding roads and public transport links.

This event had a high operational impact on the work of Children's Services and a medium impact on Property Services.

^{1,2} contact references

Three schools across the County were flooded and children and staff were stranded overnight at three more schools. Countywide, 70 schools received damage during this severe rainfall and flash flooding event.⁸

Bengeworth School in Evesham received possibly the worst damage. Built just above the 100 year flood line of the River Avon, two temporary classrooms were damaged and needed to be replaced. Luckily, new classrooms did not need to be purchased as Property Services had one in storage and one no longer needed at another school in the county. If new temporary classrooms needed to be purchased this would have dramatically increased the costs to Children's and Property Services. The school is now being relocated out of the flood risk area.⁷

Cherry Orchard First School in Worcester began to flood when the drainage system in the grounds could not cope with the amount of water the site was receiving. Early in the afternoon, the decision was taken to contact parents as the water began to flow through the grounds. It then began to rise rapidly (Berrow's Worcester Journal, 2007). The Fire and Rescue Service was called to help carry the 550 children out of the buildings to safety. Pinvin First School was also damaged by floodwater.

The insurance policies for each school cover the costs of some of the damage, other costs are being covered by Children's Services and the schools themselves.

Some pupils were unable to reach home and were forced to spend the night at school with staff until roads were passable on the Saturday. Breeden Hill School in Ashton-under-Hill, the Vale of Evesham and Thornton House Special School all had to house pupils overnight as roads became blocked.

Case Study 1 Thornton House School

Thornton House School in Worcester was due to close on Friday, July 20. After being contacted by the local authority, pupils were sent home early because of the weather conditions. With nearly all of the pupils relying on school transport to get to and from Thornton House, the transport difficulties became apparent with nursery children arriving late. Nursery children were sent straight home so as to not put them at risk as weather conditions worsened. The remaining children left early on the coaches and mini-buses with escorts only to return later the day when the buses could not reach their destinations as roads were impassable. Parents were made aware of the situation and Social Service's and members of staff provided supplies until the school transport was able to return children to their homes the following day.

The extra costs for food and heating etc. were picked up by the school itself.
(Hereford and Worcester BBC, 2007)

Not all schools were affected by flooding. Red Hill School in Worcester, which had only recently opened, is specially designed to be more robust to future changes in climate such as extreme weather events. The introduction of a Sustainable Urban Drainage system (SUDs) to the grounds stored much of the rainfall allowing it to be slowly released when ground water levels dropped. Run off was also reduced by the rainwater harvesting scheme and the sedum roof of the building holding some of the rainwater. Wide gutters with overspill points also helped to successfully guide water away. The only problem was the old storm drain system could not cope with the volume of water and forced up manhole

covers damaging the tarmac. This highlights the need for adaptation to enable systems to cope with future intense rainfall events.

For Children's Services the initial impacts involved keeping up to date with what was happening at each school. As schools need to notify the department when they close early, problems were created when not all head teachers were able to get through on the phone due to the sheer volume of calls. Local radio stations were also notified of the closures by the schools⁹.

Future plans are to set up a web site, which will be updated by Children's Services when a closure is announced so parents can access this information. Schools will still need to phone the department in order for their status to be updated.⁹

On the one hand, this flooding episode may have caused less disruption because it occurred at the end of the school year but created much more work for Children's Services. Routine planned work for the summer holidays still had to be carried out as well as clear up and repairs as a result of the flooding. As normal tasks continued, extra contractors were employed to complete all the work by the start of the new academic year.

Advice was provided for schools during the event relating to their responsibility for pupils and once the waters had receded advice with regards to clear up. This information was provided at the request of the individual school.⁸

The impact of the summer flooding was still apparent at the start of the new school term. Christopher Whitehead School in Worcester were unable to use their playing fields as they had been affected by flooding. The school needed to bus pupils elsewhere to use playing fields, incurring extra costs.

The emergency plan for dealing with these events was activated. Future planning and management will look at the locations of new schools as to avoid flood risk areas and the routes of school transport to avoid travel near watercourses.

3.14.5 Countryside Services- Worcestershire County Council

The flash flooding had a high operational impact on Countryside Services. A number of the staff were diverted to other departments and other duties such as assisting highways staff with bridge inspections and road closures. A large amount of their capital and revenue budget went on repairs to public rights of way etc. The normal work programme for the year was put on hold for many staff while repairs and clean up took place.

Areas flooded included Public Rights of Way, Countryside sites and Gypsy residential sites.

3.14.6 District Councils

Flash or fluvial flooding as a result of intense rainfall on July 20 affected all districts in Worcestershire, some more so than others. Issues such as staff having difficulties getting home were a problem. Three districts needed to set up rest centres (Worcester, Wychavon and Malvern Hills) for people who had to leave their homes.²¹

Environmental Health Officers would have been involved after the event as floodwaters may have been contaminated. Many District Councils also offered flood advice, information about applying for funding to cover damages and help with finding alternative accommodation.

In total, 156 wards in the County were affected by flooding, 16 severely. The most severely affected wards and their districts are shown below (table 3.0). This highlights that the worst affected areas across the county were in the south of Worcestershire.

Table 3.0 The most severely affected wards and districts by flooding in Worcestershire, July 2007. ¹⁶

Most Severely affected ward	District
WARNDON	Worcester City
ST CLEMENT	Worcester City
CLAINES	Worcester City
BEDWARDINE	Worcester City
ST. JOHN	Worcester City
DROITWICH CENTRAL	Wychavon
CATHEDRAL	Worcester City
ELMLEY CASTLE & SOMERVILLE	Wychavon
EVESHAM SOUTH	Wychavon
EVESHAM NORTH	Wychavon
PERSHORE	Wychavon
BREDON	Wychavon
TENBURY	Malvern Hills
TEME VALLEY	Malvern Hills
MARTLEY	Malvern Hills
UPTON & HANLEY	Malvern Hills

The number of houses believed to be at risk of flooding across Worcestershire from Environment Agency predictions was 4,784¹⁶. During this flooding only 3,366 properties were believed to be affected in Worcestershire¹⁶. Figure 3.0 compares the number of properties at risk of flooding with those that actually flooded in each district and for the county. Malvern Hills and Wyre Forest districts are the only ones where more properties flooded than were predicted. In Redditch and Bromsgrove, no houses were reported to have flooded. Countywide, far more properties are at risk of flooding than actually flooded in this event.

Comparison of properties at risk of flooding and those actually flooded July 2007

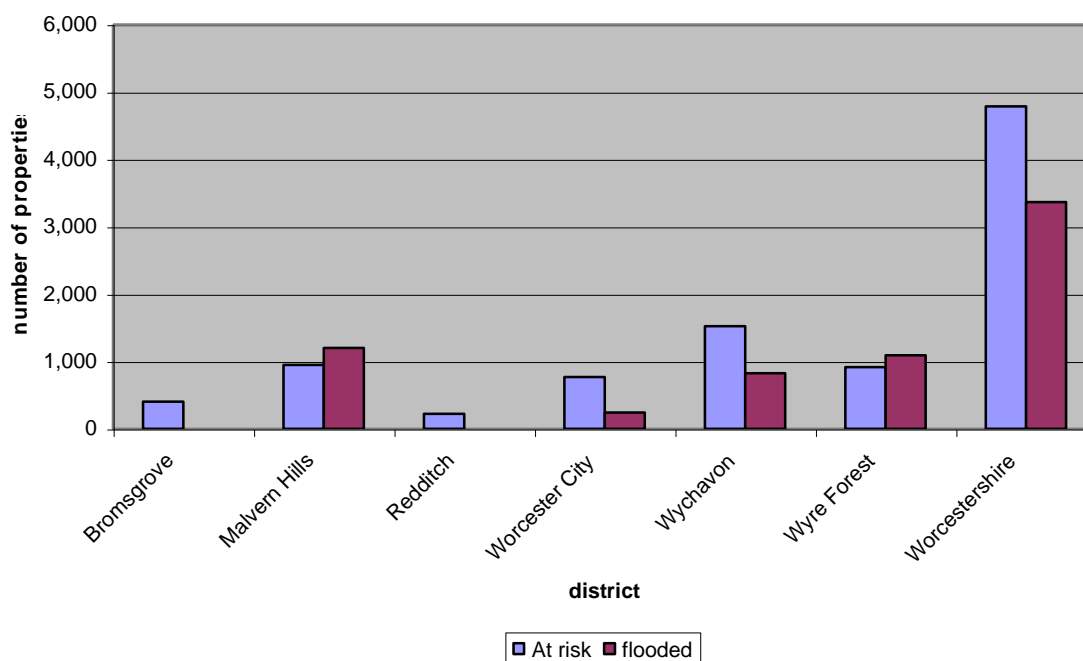


Figure 3.0 Comparison of the properties at risk of flooding and those that did flood in July 2007. ¹⁶

3.14.7 Emergency Planning Unit- Worcestershire County Council

The Emergency Planning Unit were heavily involved during this flooding as they are with all severe weather events affecting Worcestershire. Due to the nature of their role, this flooding had a high operational impact on the Emergency Planning Unit.

Their initial response once they received the weather warning from the UK Meteorological Office (Met. Office) was to set up an operations centre and a County help line for offering advice and guidance. Warnings were sent out to County Council staff via Human Resources advising staff to leave for home early once the scale of the flooding began to unfold. Press releases were regularly provided to update the public on the situation.¹⁹

A number of volunteers were on hand to assist with the help line. A member of staff was also needed at the Gold and Silver strategic and tactical response stations set up to co-ordinate the wider response of all emergency services.

The Emergency Planning team worked with a number of departments within the County Council and District Councils as well as external organisations such as the emergency services and the Environment Agency.

Assistance was given to rest centres as extra supplies were needed and thus sent from the store at County Hall. These included toothbrushes and bedding .

Although the emergency plan was very effective in the response, the team reviewed their procedures to refine the plan in preparation for future flood events.

Compared to the two previous major flood events in 1998 and 2000, July 2007 resulted in worse impacts.²⁰

Further research and information relating to trigger points would be helpful during the planning process. This would enable emergency planners to be aware of the likely impacts of different flood levels in advance of the event. River modelling information would aid work on the implications the flood barriers have on the movement and containment of floodwater. New issues with flood barriers have come to light, as it is possible in some cases they could hold water in the urban area they are designed to be protecting.¹⁹

Planning for flood events is an on going process for Emergency Planning. Plans and guidelines are continually assessed and refined as new information and knowledge is acquired.

3.14.8 Environment Agency

The Environment Agency has a key role to play during flooding. High operational impacts were felt across the organisation, especially in the Flood Risk Management team (FRM).

Flood risk warnings were issued via an automated system to the people who signed up for the scheme. Temporary flood barriers were put in place along some stretches of Worcestershire Rivers while others were left unprotected. Flooding on the River Severn left Upton-upon-Severn completely cut off from the rest of the County. It is thought that the water would have topped the flood defences if they had been in place. It may be necessary to further assess how the Environment Agency works with other organisations during such events.

There was a great deal of media interest in the whole event and it took four or five members of the team to keep the information up to date.

Bewdley's flood defences were successful in protecting the town from the main fluvial flooding.

Some properties were flooded by smaller brooks which flow through the town which do not fall under the work of the Environment Agency.¹³

Case Study 2 Flood alleviation, Kidderminster

A £6 million flood alleviation scheme completed in 2003 to protect 180 properties in Kidderminster, was successful in protecting the town from flooding in July 2007. The system stores water upstream of the town in the 700,000m³ reservoir of Puxton marshes. Later, the water is slowly released when river levels drop.

This was a joint funded project between the Environment Agency and a private developer. (Environment Agency (a), 2007)

The direct impacts on services involved all of the FRM team being out of the office dealing with issues as they arose. Staff from across the organisation were diverted away from their usual duties to help with flooding problems and the setting up of an incident centre in Tewksbury. Members of the workforce who were on holiday or in other regional offices were called in to assist. Further problems were created when the incident room was forced to move to Kidderminster after it became at risk from flood waters. For two weeks after the flooding, the Environment Agency could not deal with routine inspections, responses to pollution and other duties due to the extra work created through the flood response¹¹.

July flooding has had a long-term impact on how the organisation deals with flooding with regards to staffing and the installation of temporary flood defences. When river levels had dropped, there was then a physical response to clearing watercourses of debris. Management is needed as many rivers have now altered as a result of erosion and deposition processes changing the shape of the fluvial system.

All staff may need to be trained to deal with future events in order to have enough people to man the incident room. Restrictions relating to development of the floodplains should be an issue raised after this event. More funding should be made available for the FRM team if these flood events become more frequent.¹¹

Since the flooding in 2007 and following the Pitt Review, the Met Office and Environment Agency have formed a partnership to produce the Flood Forecasting Centre which combines meteorological and hydrological expertise to provide better forecasting of flooding.

3.14.9 Hereford and Worcester Fire and Rescue Service

At the time of writing, the statutory responsibility for response to flooding in the UK is unclear although the Fire and Rescue Service are increasingly involved with rescues from floodwater and watercourses. The Fire and Rescue Service have high volume pumping equipment, which was used during the flooding to remove water from buildings or to protect services such as drinking water and electricity supply from being put out of action.

Their response came in two phases, the initial warnings and evacuation of people from their homes and then a second wave of evacuations a few hours later when more people were put at risk. The response was mobilised early on Friday, July 20 with services such as the RNLI prepared to assist and command structures put in place. Over 1000 people were rescued on the Friday, July 20.

At Sedgeberrow, Sea King helicopters were called to pluck residents from their roofs and bedroom windows as they became trapped by rising waters.

Warnings and advice were also issued relating to the potential dangers of the electrics in flooded properties.

3.14.10 Highways and Transport- Worcestershire County Council

Highways and transport were possibly one of the worst affected County Council departments during this flooding. A large number of roads across Worcestershire were flooded and many damaged. By the afternoon and evening of July 20 around 88 roads and bridges were closed to traffic. Many cars had been abandoned where floodwaters were too deep to pass through. Some vehicles became completely submerged as water levels continued to rise. These abandoned vehicles created hazards once the water receded. Floodwater and the debris it was transporting caused damage to roads countywide. As of September 2007, roughly ten roads were still under going repair, most notably at Crophorne (B4084) where a 15m section of road collapsed exposing utility pipes. This section of road was not expected to re-open until November 2007. A further 29 roads had repair work planned as of September 2007.

Due to road closures, many travellers were unable to reach their destination with a number of motorists having to spend the night in traffic on the M5 motorway.

Public transport was also affected with a number of train lines being closed and buses being unable to use many roads¹².

3.14.11 Insurance- Worcestershire County Council

The County Council insurance deals with claims made against the Council for weather related incidences and claims for damage to council property.

The claims record beginning April 1 2007 covering the flooding in June and July for schools records five claims for flooding damage to property. 18 claims for damages were made during the same period due to heavy rain. This policy record for damage to schools only spans as far back as 01/04/2002 but over this period of time, the claims for 2007 far exceed those made previously. It must be noted that this record does not include the large floods of 1998 and 2000.¹⁷

For the policy year covering both June and July flooding, all 6 public liability claims were made against the Highways and Transport department.¹⁷

3.14.12 National Health Service (NHS)

The main impacts on the NHS were problems with access routes due to road closures. With many roads affected by flooding and some closed, staff transport was a problem.

There was no clear link with this event and the number of hospital admissions although there may have been a few localised admissions but nothing compared with the numbers of heat related admissions in other years.

3.14.13 Tourism

Worcestershire's tourism industry took a serious knock as a result of the flooding. The general weather conditions in the months leading up to the flooding had deterred many from visiting the county. The floods damaged a number of tourist attractions and hotels.

This flooding episode had a high operational impact on the tourism department. The initial response was to keep up to date with information relating to events that were postponed or cancelled and businesses that were forced to close. This was achieved by working with the local tourism centres that were receiving up to date information. Following this, the tourism department were responsible for co-ordinating information about grants provided by Advantage West Midlands and offering advice to tourism businesses about possible funding applications. The response to the flooding required the full attention of a member of staff, the most urgent work being dealt with first. Staff transport was also affected.¹⁴

The Severn Valley Railway was badly affected as repairs were still continuing from the previous month. This is seen as a major attraction for Worcestershire as it supports accommodation and other local businesses. As large sections of the track were left unsupported the service was only running between Kidderminster and Bridgenorth. Advantage West Midlands provided financial support to help the Severn Valley Railway get up and running as soon as possible.

Attractions across Worcestershire saw visitor numbers plummet. Elgars Birthplace usually has 40-50 visitors a day but numbers dropped to between four and five. Worcestershire County Cricket Club are thought to have lost income due to closure and all of the events and races had to be cancelled at Worcester Racecourse for two months while the clear up of the grounds took place. River cruise companies were severely affected through damage to boats and loss of takings.

Support for the marketing of a range of forthcoming events was also required. These events ranged from small, localised events, such as the Worcester Artists and Crafts market in October and November 2007 to larger events such as Tenbury Apple Fest

Worcestershire received around 63% of the West Midlands funding that was available for the promotion of tourist attractions and events. This funding was shared among the events requiring assistance for extra promotion.

Accommodation across the County felt the impacts of the floodwater, most notably the many caravan parks located on the floodplain. One site in particular, Weir Meadow Caravan Park, lost over 100 caravans. In Evesham, the Northwick Hotel was to be closed for 11 months for refurbishment and repairs needed after flood damage.

Around Worcestershire roughly 20 food and drink establishments were affected.¹⁴

3.14.14 Waste Management

Waste disposal was not only affected at the time of the flooding through closed roads and flooding at household waste sites but also after the events with the amount of flood damaged items being disposed of.

Hill and Moor Landfill and Household Waste site was closed on July 21 due to flooding. Across Worcestershire two further Household Waste sites were affected by flooding, located in Tenbury and Upton-upon-Severn. Some sites were closed temporarily as vehicles were unable to reach them. Temporary closures affected Droitwich, Bilford Road, Stourport and Hoobrook.

After the flooding the amount of waste being disposed of increased. The overall amount for Worcestershire for 2007-2008 was predicted to have rose by about 2000 tonnes for July compared to if no flooding had occurred. This increase in tonnage will be expected to continue over the following months as the clear up continues.

The impacts will continue for the rest of the year as the increase in land filled waste negatively affects the allowance trading. Worcestershire does not usually meet its allocated landfill target so can trade this allowance with counties which have gone over their allocated landfill tonnage.

There was an increase in the number of white goods (fridges and freezers) being disposed of. No final figure is available for this but in Wychavon, it is thought that 1500 properties were affected, most of which will need to throw away their white goods.¹⁵

3.15 October 2007 – October 2008

Between October 2007 and October 2008 there were 18 public liability claims made against Worcestershire County Council sighting weather as the cause. Ten of these claims were associated with ice and eight for excess highways water either leading to flooding of property or to an accident.

During the same period of time, a further 24 claims were made for County Council property. 18 of these were due to heavy rain. Two claims were made for lightning damage and four for storm damage as a result of high winds.

During this 12-month period, it is clear that heavy rainfall resulted in the largest number of claims but not the greatest costs in this instance.

3.16 January 2009- June 2009 (inclusive)

Between January 2009 and June 2009 there were 33 public liability claims made against Worcestershire County Council sighting weather conditions as the cause. 30 of these claims were made alleging snow/ice as the cause. One of these claims was for a lightning strike which struck the car park at the Worcester Woods Countryside causing damage to the CCTV in operation at the car park barriers at the Countryside Centre and County Hall campus.

During this period, 3 public liability claims were made for excess highways water causing flooding to property or accident. A total of five property claims were made due to heavy rain. Finally, 2 property claims were made as a result of storm damage.

3.16.1 Snowfall February 2009

Early February 2009 saw service disruption across the county as a result of snowfall. Library services were limited in some areas with Malvern mobile library, Library at home services and Alvechurch library all not operating. All open libraries, along with the Fairfield Centre, Worcester closed at 5pm. Thursday, February 5 saw a blanket closure of all Worcestershire schools by Worcestershire County Council, 255 schools remained closed

the following day. Travel was disrupted across Worcestershire with some roads being passable with care and a small number of roads closed. Bus services began to return to normal on Friday, February 6 although there were still services not operational in Redditch, parts of Malvern and Droitwich and smaller villages such as Peopleton. Further disruption to services included

- Wyre Forest District Council suspended refuse collections
- Redditch Borough Council suspended refuse collections and provided warnings for further disruption to Monday collections depending on weekend weather
- Malvern Hills District Council suspended refuse collections
- Redditch Town Hall closed at 3pm
- Palace Theatre, Redditch rescheduled a show for May 13 and Chinese New Year celebrations due to take place on February 8 were postponed until March 15
- Redditch Borough Council leisure centres were closed at 3pm and had no evening service over the weekend

Malvern Hills District Council had three extra refuse collection teams working during Saturday, February 7 to catch up on missed bin collections.

Further travel disruption on Sunday, February 8 as a result of more snowfall affecting road conditions and reducing visibility. The following day (Monday, February 9) saw freezing conditions creating hazardous driving conditions as snow/slush on main roads turned to ice. Only one complete school closure (Himbleton CE First School) and partial closure (for years 6, 7 and 8) of Waseley Hills High School and Sixth Form Centre were reported. All day centres for the elderly and physically disabled were closed for the day. Reports from Worcestershire County Council confirmed that the county was running low on grit with only 1000 tonnes of rock salt left. Alternative mixtures were being considered.

The majority of the snow had melted on Tuesday, February 10 but this created a new problem of excess surface water flooding which made conditions hazardous on some stretches of roads. Three roads were thus closed due to flooding, these were

- Jubilee Bridge, Fladbury
- Eckington Bridge, Eckington
- Farm Lane, South Littleton

Flood warnings were also in force on the River Avon.

All fords in the South of Worcestershire were closed due to water levels. Lickey Hills Primary School, Rubery announced they would be closed Thursday, February 12 as they had no grit left for the school grounds and it was considered to be dangerous as frost was forecast.

3.17 Snowfall December 2009

Snowfall caused disruption to Worcestershire County Council services between Thursday, December 17 and Wednesday, December 23.

3.18 Snowfall, January 2010

Snowfall on 5th January caused disruption across the county with over 100 schools delaying the start of the new term. Later in the month snowfall continued to affect schools with three closures/partial closures and a further 15 schools with limited opening hours. All day care centres were closed and over 40 bus routes were affected by the road conditions. The road conditions caused disruption to district services with delays to refuse collections. A further three inches of snow fell over night causing more disruption on Wednesday, January 13 with nearly 200 schools being closed or partially closed and a further 19 schools with limited opening. There were also a number of disruptions to library services such as postponement of the mobile library. The children and young people overview and scrutiny panel was also cancelled.

3.19 Snowfall, February 2010

Services across Worcestershire were again disrupted due to snowfall. Road conditions were hazardous on many routes causing travel disruption. There was also an early closure of some library services and postponement of the Malvern readers Group meeting.

4.0 Future Climate Projections

The main tool for making projections about future climate change is computer based climate models. These models are simplified statistical representations of atmospheric processes and feedbacks that allow us to assess what climate may be like in the future. The climate system is very complex; a slight change in one parameter could alter the changes we expect to see in climate. To account for this uncertainty an ensemble of models are used to provide a range of projections with each model having slight alterations to the initial starting conditions. This provides a range of model outputs showing what our future climate may be like over a defined period of time.

A variety of climate models are available which focus on different spatial scales (regional or global) and different emissions scenarios. These emissions scenarios relate to the options we have as a society to either continue to be fossil fuel dependant or to reduce emissions through changing our energy habits. This decision will ultimately influence the level to which global climate will change.

UK Climate Projections 2009 (UKCP09) are the fifth generation of climate projections for the UK. They provided probabilistic information on how the UK climate is projected to change over the 21st century in response to greenhouse gas emissions. The projections are provided for three emissions scenarios, low, medium (current emissions pathway) and high. A variety of climatic variables such as mean temperature and mean precipitation can be modelled and outputs selected for seven, 30 year time periods.

Although there is some uncertainty about the extent and speed of changes, there is confidence in the direction of the changes. Human influenced climate change will affect the long-term trend in temperatures and precipitation, but will still be subject to year-to-year and decadal variability (the climate may change but we will still get weather).

The key headlines from the climate projections for the West Midlands are:

- Milder, wetter winters (By 2020s, under a medium emissions scenario for the West Midlands winter mean temperature is projected to change between 0.6°C and 2.1°C with mean winter rainfall projected to change between -3% and 14%).
- Hotter, drier summers (By 2020s, under a medium emissions scenario for the West Midlands summer mean temperature is projected to change between 0.5°C and 2.6°C with mean summer rainfall projected to change between -23% and 12%).
- Increased intensity and frequency of severe weather events.

4.1 Future climate projections for Worcestershire

By using the data from these climate models it is possible to look at the changes we can expect to experience in temperature, rainfall and severe weather events. These projections show changes from the baseline 1961-1990 average climate.

4.1.1 Temperature projections

For Worcestershire, all seasons are projected to see an increase in mean temperature by the 2020s with the greatest mean temperature change projected for the summer months. By the 2020s, on our current emissions pathway mean temperature change during summer is very unlikely to be greater than 3.1°C and very unlikely to be less than 0.6°C.

The summer months are projected to see the greatest increase in daily maximum temperature. On our current emissions pathway, by the 2020s the mean daily maximum temperature change for summer is projected to be in the range of 0.4°C and 4.4°C.

Projections for the change in the daily minimum temperature indicate that winter minimums are likely to increase. On our current emissions pathway, by the 2020s the mean daily minimum temperature change for winter is projected to be in the range of 0.4°C and 2.75°C with extremes in the range of 0.1°C and 3°C.

On our current emissions pathway, by the 2020s, the change in temperature of the coolest day in winter is projected to be in the range of -0.9°C and 3.8°C change. The coolest day in 2006 was recorded as -3.7°C. Using the temperature ranges above for the 2020s this figure could be -4.6°C or increase to 0.1°C.

4.1.2 Precipitation projections

Precipitation is also projected to change. The table below shows the range of percentage change in precipitation.

Season	2020	2050	2080
Winter	-4% to 20%	3% to 33%	4% to 40%
Spring	-7% to 10%	-6.5% to 10.5%	-7% to 10%
Summer	-25% to 14%	-39% to 8%	-45% to 10%
Autumn	-10% to 15%	-7.5 to 16%	-5% to 16%

This highlights that over time winter rainfall is projected to increase. During the summer months by 2020s on our current emissions pathway rainfall is projected to have changed in the range of -25% and 14%.

The projections for precipitation on the wettest day are shown below

Season	2020	2050	2080
Winter	-6% to 20%	1.5% to 34%	0% to 20%
Spring	-10% to 23%	-10% to 32%	-8% to 40%
Summer	-20% to 24%	-25% to 18%	-25% to 20%
Autumn	-10% to 15%	-9% to 24%	-9% to 35%

The wettest days in summer are projected to see less rainfall over time while the wettest day in winter is projected to become wetter.

4.2 Severe weather

For the UK as a whole, some extreme weather types are predicted to become more common such as the number of day with high rainfall during winter months. Predictions also suggest a decline in the number of cold periods during winter months. During summer months we can expect heatwaves to become more common. Table 4.1 outlines the likely future impacts on services and organisations under these changing weather conditions.

4.3 Adapting to the impacts of severe weather and climate change

Research has shown the current impacts severe weather events are having on Worcestershire. Climate projections point towards an increased frequency and intensity of severe weather events which is likely to lead to further disruption to service delivery unless we now start to adapt our services to better cope with severe weather. Adaptation is about considering risks and addressing the impacts and opportunities a changing climate may bring. The risks posed by a changing climate should be considered against existing risks to avoid mal-adaptation.

There are two main types of adaptation;

- Building adaptive capacity- carrying out research, monitoring etc. to allow for decisions on the best action to be taken.

- Physical adaptation- actual changes to a way of working or a physical feature such as installing a sustainable drainage system.

There are a wide range of impacts severe weather and climate change could have on services. Adaptation options should fit in one of the following three categories;

No- regrets- measures that deliver benefits that exceed their cost, whatever the extent of climate change

Low-regrets- measures that are low cost and have potentially large benefits under a changing climate

Win-win – measures that contribute to climate change adaptation and also deliver other benefits

All adaptation options should be carefully considered taking into account the risks posed by severe weather and climate change to services.

5.0 Summary

Worcestershire is particularly vulnerable to flooding due to the local geography.

This research has highlighted that since 1997, nearly half of all severe weather events to have had a recorded impact on Worcestershire have been associated with heavy rainfall or flooding. Flooding has been very disruptive to service delivery and to the local economy through temporary business closures and loss of tourist attractions. Our dependency on our road transport has been shown to be a problem for service delivery during flooding. Roads are critical to the delivery of a number of services that support vulnerable members of the community. Once the road systems become impassable, a knock on effect to all services can be felt particularly in relation to staff numbers.

Heatwaves and generally high temperatures appear to have less of an impact on service delivery. Unlike during snow and flooding, buildings are not closed or staff relocated and services continue. The main implications are on the health of staff and service users such as school children and elderly residents relying on care services. Heatwaves are more a concern for the NHS service delivery.

The latest climate projections (UKCP09) have been considered in this research. These projections suggest that as the climate continues to change, the frequency and intensity of severe weather events is expected to increase. The projections point towards milder, wetter winters and warmer, drier summers which would alter the extremes in weather we can expect. This makes adapting to better cope with the impacts of severe weather even more crucial to service delivery. By understanding how temperature and precipitation may change and the impact this may have on Worcestershire and the services we deliver, we can increase our preparedness for such events and adapt our services accordingly.

The Worcestershire Local Climate Impacts Profile is continually being updated when severe weather events occur. This will provide a record of how services are continuing to be affected by severe weather and whether the impacts on our services change. This initial assessment of Worcestershire's current vulnerability to severe weather has been the basis for the climate change risk assessment and the adaptation action plan for Worcestershire County Council services. Worcestershire County Council will continue to assess vulnerability to severe weather and monitor climate data to ensure the use of the best available information when preparing services for future environmental conditions.

Sector/service area	Expected implications of severe weather
Adult and Community Services- Worcestershire County Council - Archaeological unit ²²	<ul style="list-style-type: none"> ● Need for temperature control during extreme high temperatures ● Evacuation plans for some care homes during flooding events ● Carers may have difficulty reaching care homes during flooding ● Restricted access to residential areas during flooding may prevent home carers reaching service users ● Snow events may restrict access to care homes and houses ● Drought will dry out deposits and destroy environmental evidence in waterlogged soils ● Site could become too hard to work during drought- need extra time for the project ● Any severe weather will make working conditions unpleasant on site ● Flooding/heavy rain could wash away deposits ● Damage to historic structures during flooding ● Delays in contract if site is too waterlogged to access ● Evaluation of new flood defences needed
Agriculture	<ul style="list-style-type: none"> ● Summer drought will halt grass and crop growth ● Severe heat may cause problems for livestock ● Damage/contamination of crops through flooding ● Cattle may need to spend more time indoors as flood/intense rainfall events become more frequent ● More frequent flood events will lead to increased cost for land clear up ● Opportunity for farmers to adapt their land (wetlands) and grow different produce (diversify) ● More money lost through frequent extreme weather events ● Possible increase in commodity price if in short supply
Biodiversity	<ul style="list-style-type: none"> ● Damage to habitats during flooding ● Summer flooding may cause loss of wader bird eggs leading to decline in their numbers ● Pollution and nutrients in flood water may starve fish of oxygen ● Flooding may leave fish stranded when waters recede

	<ul style="list-style-type: none"> • Drought conditions will leave birds with little food • Increased risk of fire during dry conditions
Children's Services- Worcestershire County Council	<ul style="list-style-type: none"> • Adaptations to buildings for safety • Increased number of days early closure due to weather conditions (less for snow days) • Difficulties with school transport during flooding • Possible need to relocate school buildings • Need for temperature regulation and shading for severe heat
Countryside Services- Worcestershire County Council	<ul style="list-style-type: none"> • Increased need for grass maintenance as growing season lengthens • Damage to picnic sites and footpaths due to flooding • Warmer summers may increase the number of visitors
County Council Buildings	<ul style="list-style-type: none"> • Need for temperature control for the comfort of staff during summer high temperatures • Flooding of staff buildings • Restricted access to buildings during flooding • Possible risk of damp during winters
Emergency Planning- Worcestershire County Council	<ul style="list-style-type: none"> • Increased frequency and intensity of severe weather events • Plans may need to be revised/adapted
Environment Agency	<ul style="list-style-type: none"> • Re asses flood recurrence intervals • Review plans for erecting flood barriers • Continued maintenance of flood defences • Flash flooding risk during heat waves, work with met. office for warnings • Conservation issues drought
Financial Services- Worcestershire County Council	<ul style="list-style-type: none"> • Increase in the number of insurance claims due to weather conditions • Possible increase of premiums • Climate proofing of structures may reduce premiums and number of claims

Sector/service	Expected implications of severe weather
Hereford and Worcester Fire and Rescue Service	<ul style="list-style-type: none"> • Increase in the number of outdoor fires during heatwaves • Possible increase in the number of water course rescues during heatwaves/high temperatures • Training limitations during droughts • An increase in the frequency of flood events would have implications for the co-ordination of response • More flood events will lead to more flood water rescues
Highways and Transport- Worcestershire County Council	<ul style="list-style-type: none"> • Risk of road closure and damage during flooding events • Road subsidence/collapse due to drought or heavy rain/flooding • Embankment instability due to heavy rainfall • Problems with road drainage during intense rainfall events, possible need to adapt drainage system • Structural damage to bridges during flooding events • Increase in the number of storms may lead to more obstructions on roads requiring clear up • Increased length of growing season will require more maintenance of grass verges
National Health Service (NHS)	<ul style="list-style-type: none"> • Increase in emergency hospital admissions during heatwaves • Rise in excess deaths during heatwaves especially for the age group 75+ • Possible spread of infections during high temperatures in hospitals • Need for ventilation in hospitals to regulate temperatures • Evacuation plans for hospitals at risk from flooding

Sector	Expected implications of severe weather
Planning- Worcestershire County Council	<ul style="list-style-type: none"> ● Revise building on floodplains ● Possibly adapt building already on the floodplain to reduce the risk of flooding ● Drought conditions could lead to building subsidence in some locations (geology dependant) ● Adaptations to buildings for extreme high temperatures
Tourism	<ul style="list-style-type: none"> ● Warmer weather conditions are likely to encourage visitor to Worcestershire ● Reduction in visitor numbers after flooding events ● Closure or postponement of attractions and events due to severe weather ● Holiday parks and other accommodation may see a decline in bookings due to weather such as heavy, intense rainfall and flooding ● Increase in storms are likely to deter visitors ● Loss of money for tourism businesses through damage due to weather events and decline in visitor numbers
Waste Management	<ul style="list-style-type: none"> ● Rubbish will decay more quickly during hotter weather ● 2 weekly rubbish collections may attract vermin during periods of severe high temperatures ● Flooding at landfill sites and surrounding access roads will cause problems with rubbish collection and disposal

Table 4.1: The expected implications of severe weather on County Council Services and external organisations

References

BBC Hereford and Worcester (2007) (online) "Flood Heroes"
<http://www.bbc.co.uk/herefordandworcester/> (accessed August 2007)

Berrow's Worcester Journal (2007) "School term ends in emergency rescue"

British Geological Survey, (2007) (online) *Geology*, www.bgs.ac.uk/science/geology.html
(accessed 17/09/2007)

Bromsgrove Advertiser (1997-2007)

Cavan, G. (2004) "Worcestershire Climate Change Impact Study", Worcestershire County Council

CFOA Operations Committee (2007) "Emergencies and Responding to Climate Change- A discussion paper" The Chief Fire Officers Association

Department for Environment, Food and Rural Affairs, (2007) (online) *Present and Future Climate Change and Impacts in the UK*,
www.defra.gov.uk/environment/statistics/globalatmos/gagccuk.htm (accessed 21/08/2007)

Department for Environment, Food and Rural Affairs, (2007) (online) *Geographic Area and Physical Context*, www.defra.gov.uk/erdp/docs/wmchapter/section11/topographic.htm
(accessed 17/09/2007)

Department for Health (2007) (online) *Heat Wave: A plan for England 2007*,
http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_074539 (accessed 28/08/2007)

Environment Agency, (2007) (online) *Climate Change*, www.environment-agency.gov.uk/yourenv/ (accessed 17/09/2007)

Environment Agency (a) (2007) (online) *Flood storage reservoir saves Kidderminster Town Centre*,
<http://www.environment-agency.gov.uk/news/1828014?lang=e®ion=Midlands%20Region> (accessed 28/08/2007)

Evesham Journal (1997-2007)

Henson R. (2006) "The Rough Guide to Climate Change", Rough Guides Ltd: London

Hereford and Worcester Fire and Rescue Service (2007) "Climate Change"

Kidderminster Shuttle (1997-2007)

Malvern Gazette (1997-2007)

Met Office (2008) (online) *Your guide to climate change*
<http://www.metoffice.gov.uk/climatechange/guide/> (accessed 22/12/2008)

National Farmers Union (2007) "The Economic Impact of the June and July floods on Agriculture in the West Midlands" NFU.

National Statistics (unknown) "The Impact of the 2003 heat wave on mortality and hospital admissions in England", National Statistics

Planning and Economic Regeneration Unit (2007) "Flooding Impact on the Worcestershire Economy, Economic Recovery Plan", Worcestershire County Council

Saunders, M. (1998) "The UK floods of Easter 1998" Benfield Greig Hazard Research Centre, University College London

The Economic impact of the June and July 2007 floods on agriculture in the West Midlands, (2007)

The Week (2007) "The summer that never was", benhamgoodheadprint

UK Climate Impacts Programme (UKCIP) (2002) (online) *Scenarios Gateway* www.ukcip.org.uk/scenarios/ (accessed 17/09/2007)

UK Climate Impacts Programme (UKCIP) (2007) (online) *Climate Change* www.ukcip.org.uk/climate_change/ (accessed 17/09/2007)

Worcestershire County Council (2007) (online) www.worcestershire.gov.uk (accessed June 2007)

Worcester News (1997-2007)

Worcester News (2007) "Farmers are counting the cost of the downpours"

Information provided from:

Reference number	Department
1	Adult and Community Services
2	Wetlands Partnership. Environment Agency
3	Wyre Forest District Council
4	Environment Agency
5	Malvern Hills AONB
6	Local Farmer
7	Property Services- Worcestershire County Council
8	Children's Services- Worcestershire County Council
9	Children's Services- Worcestershire County Council
10	Wychavon District Council
11	Environment Agency
12	Environmental Services-Finance- Worcestershire County Council
13	Hereford and Worcester Fire and Rescue Service
14	Destination Worcestershire
15	Waste Management-Worcestershire County Council
16	Research and Intelligence- Worcestershire County Council
17	Financial Services- Worcestershire County Council
18	Financial Services- Worcestershire County Council
19	Emergency Planning- Worcestershire County Council
20	Emergency Planning- Worcestershire County Council
21	Malvern Hills District Council
22	Archaeology Unit- Worcestershire County Council

Affect on Council (immediate)

Would you say this event had a low, medium or high operational impact?.....

Please provide details.....

What were the direct impacts of the event on your department or services?.....

Was there any damage to services?.....

Was there any damage to Departmental or Council reputation?.....

Which department received reputation damage?.....

Was there a change to man-hours? More employed/ change in a person's job?.....

What were the direct costs from the event?.....

What were the indirect cost from the event?.....

What immediate management, if any, was needed?.....

Affects on Council (long-term)

What, if any, were the long-term impacts?.....

What, if any, were the long-term operational impacts?.....

What long-term management was needed?.....

Have there been any long-term changes to man-hours?.....

Was there any long-term reputation damage? Please detail.....

What, if any, are the long-term costs?.....

Council response

What was WCC initial response?

.....
.....
.....

Was a policy created? Please detail.....

.....
.....

Is there an alternative policy? Please detail.....

.....
.....

What advice, if any, was provided?

.....
.....
.....

Was there any alternative advice from another organisation/source?

.....
.....

Were there any thresholds determined for future events? Details:

.....
.....

Was there a precedent response? Guidelines for a future event?

.....
.....

Responsibility for precedent.....

Was there any extra infrastructure put in-place?

.....
.....

Does this fit in with any National policy?

.....
.....

Was there any calibration with other departments or organisations? which ones?

.....
.....

Looking to the Future

Is there a need for further research relating to the event?

Details:.....

.....
.....

Does there need to be training completed in the future by members of staff? Detail:

.....
.....

Is there any further management strategies which need to be put in-place?

.....
.....

Are there any standards or restrictions that have not yet been enforced?

.....
.....

Report code:.....

Additional information