Worcestershire County Council

Part 1: Adapting to a Changing Climate

worcestershire county council

Worcestershire County Council Adapting to Climate Change

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1.0 Introduction

There is convincing evidence that our climate is changing, and that the emissions of greenhouse gases from human activities are partly responsible for the observed changes. While working to reduce the causes of climate change, and avoid catastrophic change, local authorities and their partners need to prepare for the unavoidable impacts of climate change over the next few decades. Climate change will present many risks and threats to the UK, as well as many opportunities for local authorities, businesses and their wider communities.

Globally, temperatures are rising each month, and severe weather events such as storms, flooding, gales, heat waves and droughts are becoming increasingly common. The human costs include food shortages, health risks and economic damage. Predictions show current trends continuing into the next century. Climate change is already having a wide-ranging impact on Worcestershire. In the last 100 years the growing season in the County has increased by 30 days, but in the last 10 years we have experienced extremes of drought, storm and flood unprecedented in recorded weather history, causing disruption to services and costs running into millions.

Worcestershire County Council and its partners in the Worcestershire Partnership (the Local Strategic Partnership) are committed to tackling the risks and impacts of climate change. The Local Area Agreement for Worcestershire, signed by Worcestershire County Council and other Partnership members, commits county partners to improving performance against National Indicator 188: Planning to Adapt to Climate Change (NI188). This indicator measures how far Worcestershire County Council and its partners have progressed towards assessing and tackling the effects of climate change on Worcestershire. It is separate from the other climate change-related National Indicators 185 and 186, which examine how the Council – and wider community – can reduce carbon dioxide (CO2) emissions and thereby reduce the causes of climate change.

This report is presented in 2 parts. Part 1 presents an analysis of the historical weather events that Worcestershire has experienced in the past and the projected future effects that climate change will bring over the coming decades. It is a risk based analysis that aims to identify the risks to specific service areas. Part 2 contains the Council's action plan on climate change adaptation, which in essence is a list of actions in response to the risks identified in Part 1 and which will help to prepare for the impacts of climate change and improve the area's performance in relation to National Indicator 188.

1.1 The requirements of NI188

The Department of Environment, Food and Rural Affairs (Defra) has issued guidance for local areas on how to progress towards National Indicator 188[1]. The Indicator measures the progress of local authorities and their partners in addressing climate change adaptation issues, and has five levels – as defined in the table below. Worcestershire County Council is currently assessed as achieving Level 2 with the aim of reaching Level 3 during 2010-11 as set out in the Local Area Agreement.

[1] http://www.defra.gov.uk/environment/localgovindicators/documents/ni188-guidance-2008.pdf

Indicator level	Technical definition
Level 0 - Getting started	The Authority has begun the process of assessing the potential threats and opportunities across its estate and services (for example, flood and coastal resilience plans, emergency planning, community risk registers/strategies etc) and has identified and agreed the next steps to build on that assessment in a systematic and coordinated way.
Level 1 – Public commitment and impact assessment; assembling an evidence base	The Authority has made a public commitment to identify and manage climate related risk. It has undertaken a local risk-based assessment of significant vulnerabilities and opportunities to weather and climate, both now and in the future. It can demonstrate a sound understanding of those not yet addressed in existing strategies and actions (e.g. in land use planning documents, service delivery plans, flood and coastal resilience plans, emergency planning, community risk registers/strategies etc). It has communicated these potential vulnerabilities and opportunities to department/service heads and other local partners and has set out the next steps in addressing them.
Level 2 – Comprehensive risk assessment (with prioritised action in some areas)	The Authority has undertaken a comprehensive risk-based assessment of vulnerabilities to weather and climate, both now and in the future, and has identified priority risks for its services. It has identified the most effective adaptive responses and has started incorporating these in council strategies, plans, partnerships and operations (such as planning, flood management, economic development, social care, services for children, transport etc). It has begun implementing appropriate adaptive responses in some priority areas. In its role as a community leader the council has started working with its LSP encouraging identification of major weather and climate vulnerabilities and opportunities that affect the delivery of the LSP's objectives
Level 3 – Comprehensive action plan (and prioritised action in priority areas)	The Authority has embedded climate impacts and risks across council decision making. It has developed a comprehensive adaptation action plan to deliver the necessary steps to achieve the existing objectives set out in council strategies, plans, investment decisions and partnership arrangements in light of projected climate change and is implementing appropriate adaptive responses in all priority areas. This includes leadership and support for LSPs in taking a risk-based approach to managing major weather and climate vulnerabilities/opportunities across the wider local authority area.
Level 4 - Implementation, monitoring and continuous review	The Authority and LSP are implementing the comprehensive adaptation action plan across the local authority area, and there is a robust process for regular and continual monitoring and review to ensure progress with each measure and updating of objectives. The Authority and LSP are taking appropriate adaptive responses.

2.0 Policy Drivers

In addition to National Indicator 188, other national policies are driving the climate change adaptation agenda including:

2.1 Climate Change Act (2008)

The Climate Change Act became law in November 2008. The Act requires the Government to produce a UK Climate Change Risk Assessment by 2012 and to prepare a programme of adaptation measures. The Act creates new powers to direct public bodies to address climate risks and to produce an action plan. This is where the Government included the climate change adaptation indicator (NI188) within the local government performance framework, requiring local authorities to undertake a climate change risk assessment and develop an action plan to address those risks (Adaptation Reporting Power).

2.2 The Civil Contingencies Act (2004)

The Civil Contingencies Act (2004) places legal responsibility on a number of 'First' and 'Second' responders to undertake emergency and contingency planning. Worcestershire County Council already plays an important role in the West Mercia Local Resilience Forum, which prepares the 'Community Risk Register' and coordinates emergency responses and risk-reduction strategies across a wide range of partners in the West Mercia area. The Community Risk Register for West Mercia examines risks ranging from flu pandemics and marine accidents, through to major floods, cold snaps and heatwaves. Many of the severe weather risks considered by the Community Risk Register will be affected by climate change, becoming more likely (e.g. heatwaves, high winds) or less likely (e.g. snow and ice). The Local Resilience Forum will play an important role in coordinating future responses to major risks from severe weather. Responses to more minor risks from severe weather will remain the responsibility of individual partner organisations, through their internal Emergency Planning and Business Continuity Management processes.

2.3 The Pitt Review

Following the severe floods experienced during the summer of 2007, the Pitt Review ('Lessons learned from the 2007 Floods') made a number of policy recommendations to reduce the risk of, and the impact of, flooding in future. The review identified a lack of clarity on which agency/organisations are responsible for surface water drainage. The subsequent Flood and Water Management Bill clarifies this by giving local authorities responsibility for surface water drainage, and requires them to prepare Surface Water Management Plans in collaboration with the Environment Agency and water companies. Worcestershire County Council has made good progress in producing plans, including Multi Agency Flood Plans that include a community-level assessment of flood risk in relation to rivers, groundwater, surface water and flood defences including over topping / failure of flood defences. This has made a significant contribution to climate change adaptation work by reducing the risk of pluvial (rain-related) and fluvial (river-related) flooding.

2.4 National Heatwave Plan

Heatwave conditions are defined by the Met Office as temperatures above 30°C during the day and above 15°C at night. Significant health impacts and increased deaths were recorded nationally during July 2006, when temperatures exceeded these levels for more than a week. In response to this, and to the potential warming impacts of climate change, the Department of Health has developed a National Heatwave Plan for England (2010). This includes a 'Heat-Health Watch System' for use by health and social care providers. The 'Heat-Health Watch System' uses a series of levels of heatwave alerts, in partnership with the Met Office, ranging from green through amber to red. The Heatwave Plan identifies factors which increase health risks from heatwaves, and presents a range of measures that local services can put in place to provide cooler spaces and reduce health risks during heatwaves.

3.0 The Changing Climate

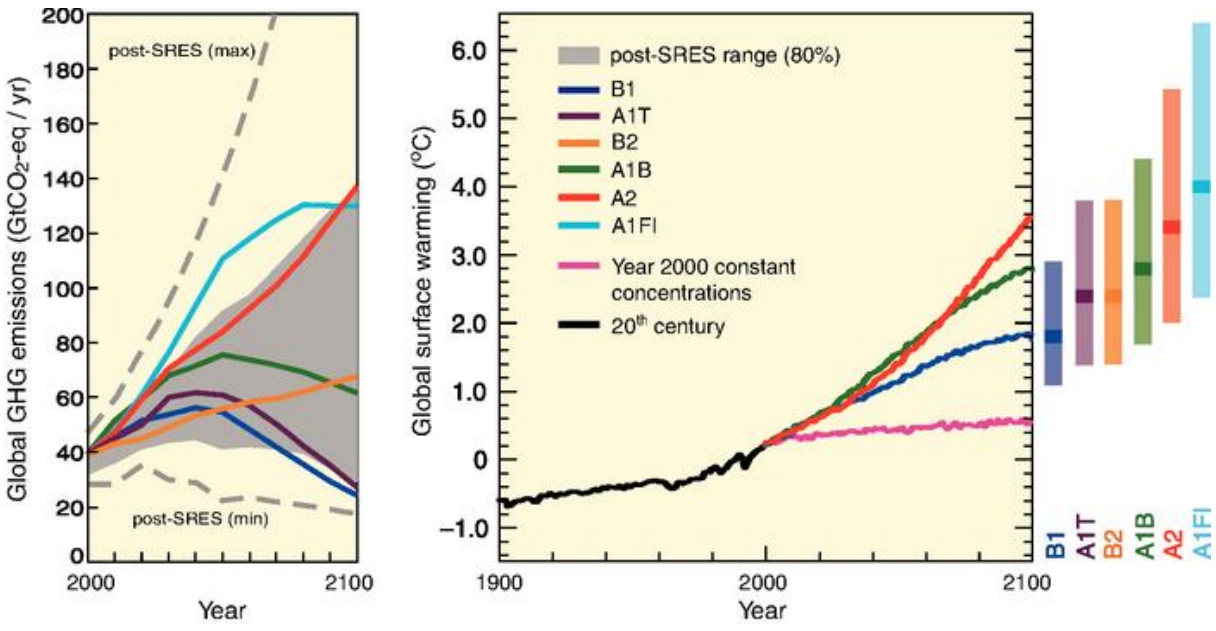
3.1 Observed changes in the global climate

The most recent Fourth Assessment Report (AR4) from Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC, 2007), stated that the:

'warming of the global climate system is unequivocal, with global average temperatures having risen by nearly 0.8 ºC since the late 19th century, and rising at about 0.2 ºC per decade over the past 25 years'.

The IPCC has projected the average surface temperature of the Earth is likely to increase by 1.1 - 6.4°C by the end of the 21st century, relative to 1961-1990, with a best estimate of 1.8 - 4.0°C.

Scenarios for GHG emissions from 2000 to 2100 (in the absence of additional climate policies) and projections of surface temperatures



The IPCC Scenarios – in brief:

A1F1 - very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient fossil-intensive technologies;
A2 – high population growth but slow economic development and slow technological change;
B2 – intermediate population and economic growth, with local solutions to economic, social and environmental sustainability;
B1 – the same global population as A1FI but with more rapid changes in economic structures towards a service and information economy.

As a result of global warming, the IPCC report presents evidence to suggest that it is:

- **Very likely** that hot extremes, heatwaves and heavy precipitation events will become more frequent;

- **Likely** that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases in tropical sea-surface temperatures;

- **Very likely** that there will be increases in precipitation in high latitudes, while decreases are likely in most subtropical land regions, continuing observed patterns in recent trends.

3.2 Climate versus weather

'Weather' is what we experience over a short period of time – over an hour or a day. 'Climate' is the average weather and its variability over a long period of time (at least 30 years). It is important not to confuse short term weather events (for example the cold winter of 2010), with long-term trends (for example, winters warming by over 2˚C by the mid century).

For example, the winter of 2010 was one of the coldest for 20 years. In most winters, south-westerly winds from the Atlantic mean that the UK benefits from comparatively warm, but wet winters. In mid-January 2010, the Atlantic air was 'blocked' by a high-pressure weather system, and cold air from the Arctic drove temperatures down. Meanwhile, a low-pressure system from the northeast brought moisture that fell as snow.

The Met Office's seasonal forecast predicted the potential for an unusually cold spell. This spell of cold weather in the UK and parts of Europe does not mean that climate change has stopped. In the UK, 2009 was in fact the 15th warmest year on record and taking the globe as a whole, 2009 was the fifth warmest year on record. Cold weather events will continue to occur in the future, but will become increasingly less common.

3.3 Observed changes in the UK climate

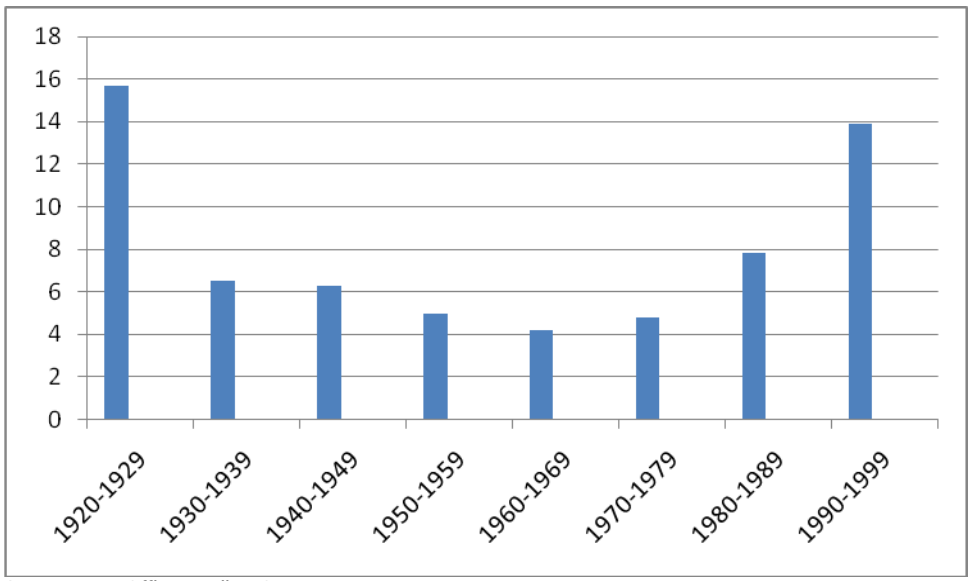
According to the UK Climate Impacts Programme (UKCIP), recent observed trends in climate change in the UK have shown that:

- Central England Temperature has risen by about a degree Celsius since the 1970s, with 2006 being the warmest on record. It is likely that there has been a significant influence from human activity on the recent warming;
- Temperatures in Scotland and Northern Ireland have risen by about 0.8 ºC since about 1980, but this rise has not been attributed to specific causes;
- Annual mean precipitation over England and Wales has not changed significantly since records began in 1766. Seasonal rainfall is highly variable, but appears to have decreased in summer and increased in winter, although with little change in the latter over the last 50 years;
- All regions of the UK have experienced an increase over the past 45 years in the contribution to winter rainfall from heavy precipitation events, albeit marginally in Northern Ireland and North West England; but
- In summer all regions except North East England and Northern Scotland have experienced a decrease in the contribution of heavy precipitation events to summer rainfall.

3.4 Storms and high winds

Severe windstorms around the UK have become more frequent in the past few decades, though not above that seen in the 1920s. There is not yet a scientific consensus about how this effect relates to climate change.

The total number of severe storms per decade over the UK and Ireland during the period October to March, from the 1920s to the 1990s.



Source: Met Office Hadley Centre

4.0 Evidence of past Weather Events in Worcestershire

To explore the potential impacts of extreme weather events that are likely to accompany climate change the Council undertook a 'Local Climate Impacts Profile' (LCLIP) for Worcestershire. This involved a review of media records and departmental records from 1997 to 2010 about extreme weather events and their implications for the Council and the wider community.

The LCLIP approach is advocated by the UK Climate Impacts Programme and has been followed by many local authorities in the UK. Although its focus is on looking back at past weather events, the aim is to raise awareness of the potential for future changes in climate and weather-related events, and the issues that the Council and its partners are likely to face in future.

The LCLIP found Worcestershire has been influenced by over 50 weather events between 1997 and 2010; over this period nearly 50% of events were flood/heavy rain related but also included storms and severe heat.

4.1 Prolonged heat above 30^{o}C

During the summers of 2003 and 2006, prolonged high temperatures created difficulties for a number of service areas most notably relating to health implications. High temperatures are already highlighting areas for change for example in the use of materials for road surfaces.

The heat wave of 2003 affected many European countries, the UK included. Devastating outcomes were seen across France as large numbers of the population died as a result of high temperatures. Records were broken in the UK as temperatures in some regions climbed to 38^{o}C. In Worcestershire, temperatures lingered around 32-34^{o}C with little relief at night. The maximum temperature for the West Midlands region was 35^{o}C and did not drop below 29^{o}C (National Statistic, 2007). The movement of the high-pressure system north from the Azores, positioned high temperatures over England causing many health issues associated with pollution as well as heat.

The summer of 2006 saw temperatures of 34^{o}C being reached 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. 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.

4.2 Flooding

The flash flooding in July 2007 came as a result of intense, persistent rainfall on the 20th which affected the whole of Worcestershire after a period of generally wet weather. The impacts were felt on varying scales, from homes, businesses and roads being flooded in Worcester to Upton-upon-Severn being completely surrounded by water, cut off from the rest of the county.

The impact of the 2007 floods on the community was exceptional with 552,900 Worcestershire residents affected; 3,366 residential properties and 747 businesses were flooded. The economic cost to the county was estimated at £6.4 million per week during the height of the flooding. Approximately 10% of the land area of Worcestershire

is at risk of flooding the second highest percentage of total land at risk from flooding in the West Midlands. In Worcestershire, the number of properties at risk of flooding has reduced in 2010; there are 9039 properties at risk which is 3.6% of total properties in Worcestershire; 4653 properties at risk of 1 in 100 year flood and 9039 at risk of 1 in 1000 year.

The floods also impacted the Councils services where Home Carers were restricted in their access to the residents they usually visited as roads were impassable and two care homes had to evacuate residents to other centres. Schools were forced to close early due to the rain and flash flooding either affecting the school buildings or the surrounding roads and public transport links. 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.

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 the 20th July 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.

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, mainly due to their riverside locations.

4.3 Sudden cold snaps

The snow falls during February 2009 caused severe disruption across Worcestershire and affected many services. Waste collections were suspended across south Worcestershire because conditions were too treacherous for the vehicles to be deployed. At times all 250 state schools were closed due to the hazardous road conditions. This problem was exacerbated by a national shortage of grit.

The use of grit became less effective as the snow began to melt and flooding was caused by a combination of rainfall and snow melt which left parts of the county with the equivalent of 18mm of rainfall.

Approximately 3,000 homes in Worcestershire, Herefordshire and Gloucestershire were left without electricity when power lines came down in the snow due mainly to the build-up of snow and ice causing branches to snap and fall on power lines or trees falling over and dragging down the power lines. Day Care Centres were forced to close due to the risk of injury in transiting to and from the locations and there were problems with the conditions of roads as the numbers of potholes increased.

4.4 Storms

During 2003/2004 8 claims for property damage were made against the Council's insurance as a result of lightning strikes during storms causing damage to council properties. The total for these claims was £10,007. Damage caused by lightening strikes in 2005/2006 has been the most costly with 7 claims totalling £125,284.

5.0 Predicting Future Climate Trends within Worcestershire

The following predictions of future climate trends within Worcestershire are based on the climate change scenarios published by the UK Climate Impacts Programme (UKCIP) through the UK Climate Projections 09 (UKCP09).

The Met Office Hadley Centre have developed a methodology to provide probabilistic climate projections to describe the future climate for each 25 x 25 km grid square in the UKCP09 25 km grid (covering the UK) and for certain pre-defined aggregated areas.

A probabilistic climate projection is a measure of strength of evidence in different future climate change outcomes. This measure is dependent on the method used, is based on the current evidence available and encapsulates some, but not all, of the uncertainty associated with projecting future climate change. The maps, graphs and key findings for UKCP09 are a quick way to see projected changes in the UK climate at a national and regional level.

The UKCP09 climate change scenarios provide four alternative descriptions of how the climate of the UK might evolve over the course of this century. These alternative descriptions result from uncertainty about future trends and behaviour – such as population growth, socio-economic development and technological progress – and how these might influence future global emissions of greenhouse gases.

In UKCP09, projections are developed under three different emissions scenarios based on their relative greenhouse gas emissions levels – High, Medium and Low. The analysis conducted for this report is based on the Medium emissions scenario model. All changes in climate are given relative to the baseline period of 1961 to 1990.

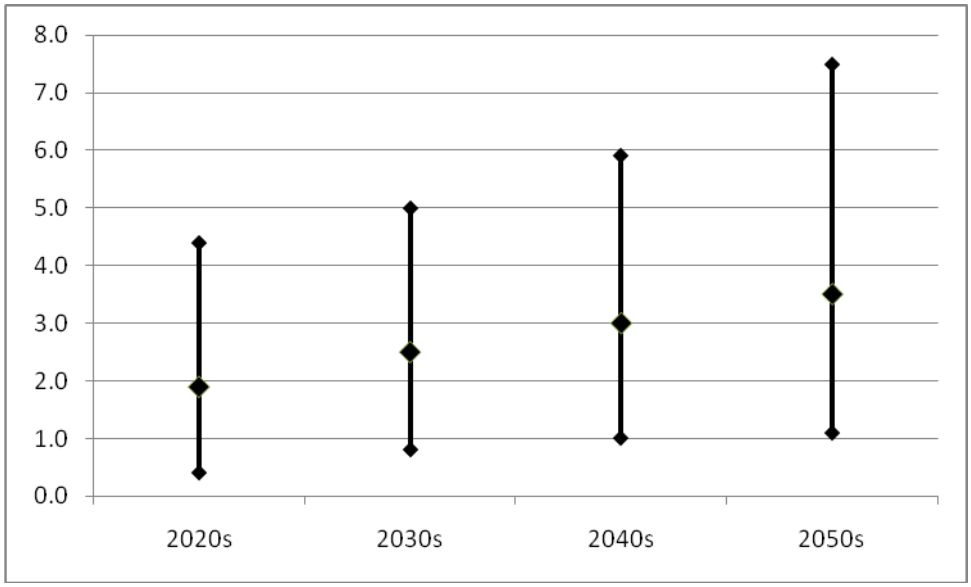
Probability levels associated with a given change should be interpreted as indicating the relative likelihood of the projected change being at or less than the given change.

For example, if a projected temperature change of +4.5°C is associated with the 90% probability projection at a particular location in the 2050s for the UKCP09 medium emission scenario, this should be interpreted as it is projected that there is a 90% likelihood that temperatures at that location will be equal to or less than 4.5°C warmer than temperatures in the 1961–1990 baseline period. Conversely, at the other end of the scale, there is 10% likelihood that those temperatures will be greater than 4.5°C warmer than the baseline period.

5.1 Changes in Temperature in Worcestershire

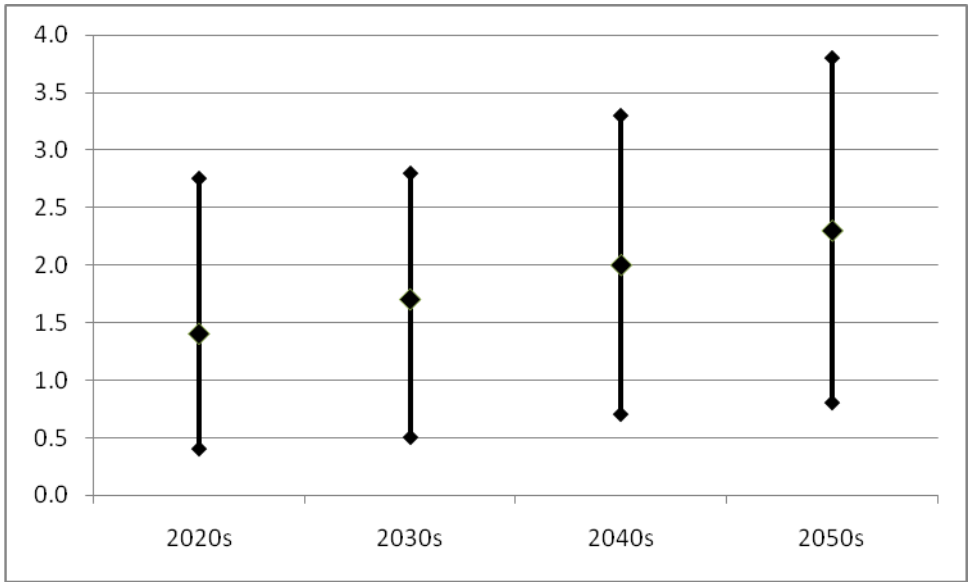
The following graphs are produced from UKCP09 data for a medium emissions scenario for the periods 2020s to 2050s in Worcestershire. The impact bars show the ranges based on 10% probability (bottom marker) 50% probability (central marker) and 90% probability (top marker). According to UKCIP, future increases are very unlikely to be outside these ranges.

Change in Mean Daily Maximum Summer Temperature °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; increasing to a range of 1.1°C and 7.5°C by the 2050s.

Change in Mean Daily Minimum Winter Temperature °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; increasing to a range of 0.8°C to 3.8°C by the 2050s.

Potential Impact - In cases of extreme temperatures, heat-related death/illness could increase but this is likely to be offset by milder winters leading to a fall in cold related winter deaths.

5.2 Changes in Precipitation in Worcestershire

Precipitation is also projected to change. The table below shows the range of percentage change in precipitation on a seasonal basis for the 2020s and 2050s.

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

This highlights that over time winter rainfall is projected to increase. During the summer months by the 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.

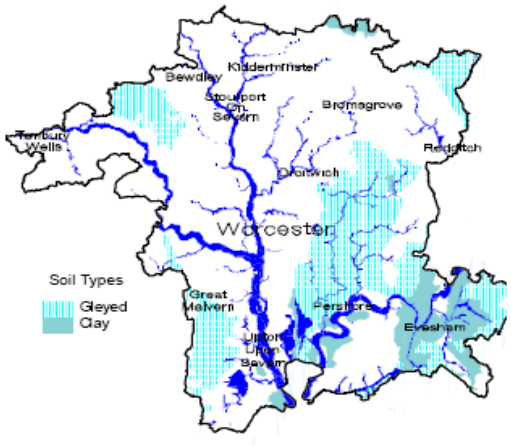
Season	2020	2050
Winter	-6% to 20%	1.5% to 34%
Spring	-10% to 23%	-10% to 32%
Summer	-20% to 24%	-25% to 18%
Autumn	-10% to 15%	-9% to 24%

The wettest day during 2008 occurred during September (27.9mm). By the 2020s the wettest day in autumn is expected to change by between -10% and 15%. Therefore the wettest autumn day could reduce by 10% (25.11mm using 2008 figure) or increase by 15% (32.09mm using 2008 figures).

5.3 Risk of Flooding in Worcestershire

Flooding is considered to be a major issue for Worcestershire. Over the years, floods have occurred as a result of rivers such as the Severn, Avon and Teme bursting their banks and through flash flooding as a result of intense rainfall. In Worcestershire, approximately 10% of the land area is at risk of flooding.

The map below shows areas identified as particularly at risk from the climate change impact in terms of flooding.



Source: The Impact of Climate Change on Worcestershire – G Cavan 2004

In the 2006 State of the Environment update, the number of properties at risk of flooding was around 4000. This figure increased over time but and as the climate is predicted to change and bring with it an increased frequency and intensity of extreme weather events such as heavy rainfall, it is likely Worcestershire will see more flooding incidents.

Through the Local Area Agreement (LAA) there is a requirement to report on flooding. In Worcestershire, a local indicator on flooding (reduce the risk of flooding (both fluvial and pluvial) throughout the County) has been adopted.

Current flooding risk data shows that Worcestershire has 9039 properties at risk which is 3.6% of total properties in the county. 4653 properties at risk of 1 in 100 year flood and 9039 at risk of 1 in 1000 year.

6.0 Managing Climate Change Risks

Risk is generally defined as a combination of the **likelihood** of an occurrence and the **Impact** (or consequence) of that occurrence. In practice, neither the likelihood nor the consequences are known with certainty. In the context of climate change risk assessment, uncertainty arises because, although we can be confident the climate is changing, we do not know precisely the magnitude of the changes or their associated impacts.

Risk assessment may involve quantitative or qualitative techniques and information to describe the nature of risks. Qualitative techniques are particularly useful in circumstances, such as with climate change, where there is uncertainty about likelihood or impact. Notwithstanding sources of uncertainty, the evidence discussed above will provide the basis for identifying and prioritising risks of climate change. The process is supported by climate projections and only requires a general understanding of the impacts of climate change. However, a comprehensive understanding of the Council's services and sound professional judgement are equally important.

The risks identified in the following assessment process are designed to provide the Council with a comprehensive list for consideration when identifying potential adaptation strategies. Having undertaken the initial risk assessment process, it may be necessary to consider other risks that specifically impact certain service areas and that warrant further analysis.

Some climate change risks are complex matters, with impacts affecting several (or in some cases all) service areas. In many cases the assessment process will enable a service area to identify and prioritise the risks that it faces from climate change and to develop and implement treatments, either through mitigation or adaptation.

Once a risk is well understood and it is clear that some treatment will be required, detailed analysis of treatment options may be required. There will likely be several options, each entailing different costs and benefits and each offering a different level of risk mitigation or adaptation.

6.1 Risk Assessment Process

The Risk Identification Matrix provides a mechanism for assessing and ranking risks. The Likelihood is assessed on a continuum ranging from Almost Impossible to Very High.

Likelihood				
Very High	9	19	21	24
High	8	12	20	23
Medium	4	11	15	22
Low	3	10	14	18
Very Low	2	6	13	17
Almost Impossible	1	5	7	16
	Negligible	Substantial	Critical	Extreme
		Impact		

Risk Identification Matrix

The following table provides examples for each descriptor for assessing the Impact.

Extreme	Death	**Substantial**	Medical treatment required - long-term injury
	Medium term loss of service capability		Shot-term loss disruption of service capability
	Adverse national publicity		Needs careful public relations
	More than 50 people involved/affected		No more than 10 people involved
	Litigation almost certain and difficult to defend		High potential for complaint, litigation possible
	Breaches of law punishable with imprisonment		Breaches of regulations/standards
Critical	Extensive, permanent injuries, long-term sick	**Negligible**	No injuries beyond 'first aid' level
	Shot-term loss of service capability		No significant disruption to service capability
	Adverse local publicity		Unlikely to cause any adverse publicity
	Up to 50 people involved		No more than 3 people involved
	Litigation to be excepted		Unlikely to cause complaint/litigation
	Breaches of the law punishable by fines only		Breaches of local procedures/standards

The risk equation is therefore the product of the **Likelihood** and the **Impact**. The assessment of these produces an evaluation of the risk associated with each activity on a rising scale from 1 to 24 to determine the respective level of risk.

The Risk Matrix illustrates how risks may be ranked from the lowest risks (a likelihood of 'almost impossible', with 'negligible 'impact), through to the highest risks (a 'very high' likelihood, causing an 'extreme' impact).

Example: Where the Likelihood is assessed as **Medium** and the Impact assessed as **Critical** the overall risk would be assessed as **Amber** with a **Risk Ranking** of **15**.

The level of probability (Likelihood) and the impact descriptors/examples listed above are a guide only. Quantitative or historical data can also be used to assist in assessing risks although the most common approach to measuring the likelihood or frequency of a risk is totally subjective. Whilst this method can be criticised for its lack of hard evidence to support the judgement it is a perfectly valid technique to use; however, the assessments made in this report should be reviewed in more detail by each service area.

7.0 Risks to the Council's Services and the Wider Community

Based on the potential impacts identified through historical evidence and climate projections, a risk assessment has been developed using the Council's risk assessment methodology. The risk assessment covers the main themes as follows:

- General threats from climate change
- Increased risk of flooding
- Increased risk of drier, hotter weather (prolonged heat over 30^{o}C)
- Increased risk storms/gales

7.1 General Threats from Climate Change

General Threats from Climate Change	Likelihood	Impact	Risk Ranking
Extreme weather events may cause injury, stress and deaths to staff and public	Medium	Extreme	22
Extreme weather events may cause damage to buildings, transport and other infrastructure, thereby restricting public access to services (e.g. schools, care homes, medical facilities, WCC offices, housing, business property, sports/tourist facilities etc.)	High	Critical	20
Cost of climate change impacts, and adaptation responses, will lead to budget pressures, including: high cost of improving the resilience of transport and drainage infrastructure	Medium	Critical	15
Budget pressures include: cost of repairs/adaptations to existing buildings to cope with extreme weather events	Medium	Critical	15
Budget pressures include: higher capital costs for climate friendly design of new buildings, including housing and schools	Medium	Critical	15
Higher construction costs ate likely to reduce capital receipts and may constrain regeneration investment	Medium	Substantial	11
More extreme weather events are likely to increase public demands on local authority services, care services, flood response services and emergency services	Medium	Critical	15
Property damage may lead to temporary closure of essential services, including those involved in emergency response	Medium	Critical	15
Extreme weather events may have a negative impact on business and lifestyle, leading to economic impact/lost revenue	Medium	Substantial	11
Increased compensation claims likely (e.g. injury or death due to flooding – public or employees suing council/businesses)	Low	Critical	14
Extreme weather events may lead to loss of or damage to key/critical infrastructure (e.g. highways)	Medium	Extreme	22
Failure of power and other utilities, owing to flooding or storms, may put lives of vulnerable children/adults at risk	Medium	Extreme	22
Extreme weather events may cause temporary interruption to essential services (e.g. power, water supplies, communications, alarm lines, underground cables)	Medium	Critical	15
Impacts fall disproportionately on vulnerable members of the population and deprived areas – risk of increased deprivation	Medium	Critical	15
Increased frequency of extreme weather events, and associated claims, are likely to increase insurance premiums – potential difficulties for some people/businesses to get insurance (for the Council, businesses, public and third sector, wider community)	Low	Substantial	10

7.2 Risks specific to Flooding

Risks specific to Flooding	Likelihood	Impact	Risk Ranking
High cost of altering existing water supply and drainage infrastructure to improve resilience and reduce flood risk	High	Critical	20
Flooding brings risk of sewer overflows and faecal contamination – reducing access to drinking water, increasing the risk of disease and requiring clean-up	Medium	Extreme	22
More frequent high intensity storms and heavy rainfall lead to increased flood risk, with implications for property, infrastructure, cleansing, health and safety of staff and public.	High	Extreme	23
High risk of pluvial (rain-related) flooding affecting (approx) up to 50 households unless gullies and sewers are clear – particularly in autumn due to leaf fall	High	Critical	20
Stress, anxiety and long-term emotional/physical impacts on vulnerable residents affected by flooding (including relatively minor pluvial flooding)	Medium	Critical	15
Serious/flash floods may affect access by older and vulnerable people to medications, personal care, food and may have implications dehydration and demand for hospital beds	High	Critical	20
Flooding may cause major disruption to transport (e.g. roads temporarily blocked or more permanently damaged by collapse of sewers and drains) – with consequences for many aspects of service delivery	Medium	Extreme	22
WCC/partner buildings in areas at risk from flooding may need to be closed and services moved to more appropriate locations	High	Critical	20
High risk of flood and storm disruption have implications for tourism and local economies	Medium	Substantial	11

7.3 Risks specific to Drier, Hotter Weather

Risks specific to Drier, Hotter Weather	Likelihood	Impact	Risk Ranking
Heatwaves cause damage to transport infrastructure, leading to disruption (e.g. buckled rails, soft tarmac, traffic signal controllers overheating)	Medium	Extreme	22
Heatwaves may cause increases in deaths, owing to dehydration, heat exhaustion or food poisoning, particularly amongst children, older people and vulnerable adults	Medium	Extreme	22
Heatwaves likely to cause more risk-taking behaviour by individuals (e.g. entering lakes, ponds) – risk of injury or death	Medium	Extreme	22
Heatwaves are likely to increase demand for water and electricity (e.g. cooling for people and buildings) – cost and carbon implications	Medium	Critical	15
Increased summer temperatures will mean that regular bio-degradable waste collections/disposal need to be considered, possibly commercial as well as domestic – implications for costs, facilities etc.	High	Substantial	12
Increase in pest and insect infections, including rats – implications for cost/health and for management of parks and green spaces	Medium	Substantial	11
Increased temperatures will lead to increased risks of fire and arson (particularly for grassland, agricultural holdings)	High	Substantial	12
Health impacts of hotter, drier summers on public and staff (particularly those working outdoors): increased risk of sunburn / skin cancer, sight problems (cancer and cataracts), respiratory problems – unless adequate shade/protection is provided	High	Extreme	23

7.4 Risks specific to Storms and Gales

Risks specific to Storms and Gales	Likelihood	Impact	Risk Ranking
High winds/storms lead to increase in the number of dangerous buildings, potentially causing injury or death to staff or members of the public	Medium	Extreme	22
High winds bring major risk of trees falling, in woodland and elsewhere – leading to damage to infrastructure; potential injury and loss of life; disruption to traffic; and demands on council services	Medium	Extreme	22
Storms cause serious damage to buildings and infrastructure, creating costs and diverting resources	Medium	Critical	15
Storms and high winds likely to lead to cancellation of outdoor events – implications for tourism and local economies	Medium	Substantial	11

It's not all bad news

Warmer temperatures in the UK may well be seen as positive and welcomed by many people. The introduction of different animals and plants could have its benefits, as well as negatives. Our lifestyles could change dramatically and we could spend more time taking part in outdoor activities, particularly during the summer months. Employment patterns could change and the tourist industry in the UK should improve creating jobs throughout the country. Although some negative aspects will be felt in agriculture, there will be the opportunity for the production of new crops. An increase in vineyards, sunflower plantations and other farming could all be potentially lucrative fields of agriculture.

7.5 Opportunities generated by Climate Change

Opportunities generated by climate change
Opportunities to grow city economy and employment via industries which can benefit from climate change (e.g. environmental protection, insulation, renewable energy, tourism)
Change in climate should provide greater potential for non-carbon energy production in Worcestershire (e.g. solar, wind)
Hotter, drier summers are likely to lead to growth in tourism (more people holidaying in UK) and enhancement of 'Barcelona-style' pavement café culture – bringing benefits for the city economy
Opportunities for skills development/training in specialist areas to support this growth
Hotter, drier summers likely to lead to increased usage of green spaces and increased demand for outdoor facilities/events – bringing opportunities for business and increased income-generating opportunities
Higher profile role for green infrastructure (role in offsetting carbon footprint and improving people's quality of life during warmer, drier summers)
Warming temperatures will gradually change the range of crops that can be grown locally, opening up new markets
Reduced need for winter heating in Council buildings, schools, businesses and by people in the community, with consequent reduction in fuel bills
Reduced cold-related illnesses (respiratory, pulmonary) and less demand on services relating to these
Improved public health, fitness and well-being from increased outdoor activity and use of green spaces during warmer, drier summers
Potential reduction in obesity amongst children and young people as a result of more active lifestyles
Increased incidence of climate change impacts may help to build awareness, contributing to improved community and individual resilience, improved cohesion and greener ways of living

8.0 Climate Change Adaptations

Adapting to climate change impacts is a complex task but has been highlighted as a natural response to extreme weather events to improve resilience and take advantage of emerging opportunities.

Early planning for the impacts of climate change is likely to bring considerable advantages. Many decisions made today will have consequences for decades. It is cheaper, for example, to design new housing or infrastructure to cope with a future climate than to retrofit later.

8.1 Adaptation Planning

Adaptation planning will be more effective if it is systematic and strategic. Such an approach will:

- engage stakeholders
- identify and set priorities for action
- assign responsibility for action and monitor implementation
- keep adaptation strategies under regular review.

Adaptation planning is unlikely to succeed if done in isolation from other activities. Adaptation will probably require a special focus and dedicated resources, but must build into existing practices and strategies. One outcome of adaptation planning may be to modify existing practices and policies. Risk management is one useful approach to adaptation planning.

Adaptation planning involves judgements about the best strategy in the face of uncertainty about future climate change. A flexible approach is necessary in order to avoid the dangers of:

- Under-adaptation - when climate change factors are given insufficient weight in decision making
- Over-adaptation - when climate change factors are given too much weight in decision making
- Mal-adaptation - when decisions are taken that make an activity or region more vulnerable to climate change.

Some ways to retain flexibility include:

- Avoid decisions that constrain future adaptation options.
- Use an approach such as risk management that allows for regular review of adaptation strategies and their outcomes. This may involve a phased approach to implementation where more costly options are activated as uncertainty is reduced.
- Identify adaptation options with multiple benefits.

8.2 Adaptation Options

The following table provides possible climate change scenario based adaptation responses.

Local Authority Service	Potential Impacts of Climate Change	Examples of Possible Adaptation Responses
Planning		
Forward Planning and Developmental Control	Higher risk of flooding/erosion of susceptible developments in floodplains or coastal margins	Ensure planning takes account of future trends in flooding and coastal erosion. Consider range of options for flood and coastal management, including promoting appropriate and sustainable defences (with the Environment Agency where appropriate) and locating new development away from areas of highest risk
		Incorporate landscape features to absorb water within developments
	Hotter drier summers could further increase pressure on water resources	Consider potential water supply/demand issues when siting new development
	Improved summer climate provides greater potential for outdoor living	Consider how Strategic and Local Plans can accommodate changes in recreational needs
Emergency Planning	Increased risk of flooding and severe weather	Ensure emergency procedures and equipment are updated to meet increased risk
Housing and Buildings		
Housing	Increased risk of subsidence as soils shrink in hotter drier summers	Plan for preventative and remedial maintenance of existing stock
	Higher risk to houses in floodplains or coastal margins	Consider restricting development in the floodplain and coastal margins for new housing, and instigating a range of flood-proofing measures or sustainable defence measures for existing properties
	Temperature increases affect living space environment	Use thermal properties of materials to improve cooling and retrofit energy efficient systems
Management of public buildings	Temperature increases affect thermal comfort	Retrofit or upgrade energy efficient heating and ventilation
	Wetter winters causing damp, condensation and mould problems	Upgrade weatherproofing systems and manage internal environment
	Higher risk to buildings currently located in floodplain or coastal areas	Consider flood-proofing measures or relocate
Building Control	Drier summers increase risk of foundation subsidence	Consider changes to procedures and inspections to ensure foundations are resilient
	Wetter winters and severe weather increase damp problems	Consider updating procedures to include measures for wetter conditions
Building Design Services / Architecture	Climate change influences future design (in response to above)	Rethink built environment design and revise practice to suit
		Make use of thermal properties of materials to improve cooling
		Reduce solar heating using recessed windows, roof overhangs and shades

Local Authority Service	Potential Impacts of Climate Change	Examples of Possible Adaptation Responses
Transport and Highways		
Transport Planning	Increased risk of flood disruption due to wetter winters and severe weather	Plan to flood-proof or re-site infrastructure and plan routes to minimise disruption
	Increased temperature causing service disruption and heat stress to travelling public	Avoid exposed places and provide shade or cooled waiting areas
Highway Maintenance	Increased rainfall intensity affecting embankments and bridge piers and washing more debris into gullies	Increase monitoring and maintenance of embankments and bridge piers, and increase gully emptying activity
	Drier summers increase risk of road subsidence and higher temperatures increase risk of surface damage	Re-examine road structural design. Implement remedial work for existing roads
	Higher risk to roads located in floodplain or coastal areas	Aim to flood-proof or re-site strategically important roads
	Increase in rate of growth and length of growing season of road verges	Use slower growing plants in landscape schemes. Revise mowing/weed control schedule
	Warmer winters with reduced risk of frost	Reduced need for road salting
Health and Social		
Health and Social Services	Higher risk of skin cancer/ sun burn due to hotter summers and increased outdoor recreation	Consider ways to increase awareness of dangers of exposure. Provide more shade in public recreational areas
	Heat stress to the old, poor and vulnerable communities and people likely to increase	Ensure adequate shade and cooling available
Environmental Health	Higher temperatures likely to increase cases of food poisoning	Consider ways to increase awareness of food hygiene practices and revise best practice
	Higher levels of dust in the air due to drier summers	May need to hose down streets in urban areas
Environmental Services and Awareness		
Greenspace Management	Increase in rate of growth leading to year-round grass maintenance	Adapt maintenance schedules and resources to meet change
	Loss of trees and shrubs due to drier summers and wetter winters	Plant trees and shrubs that will tolerate future conditions
	Climate change influence on natural environment	Plan for wildlife corridors to allow natural migration
Watercourse Management	Wetter winters and increased rainfall intensity causing local flooding	Increase ditch clearing and gully emptying activities to obviate blockages
Waste Services	Rubbish will decay more rapidly in higher summer temperatures	More frequent waste collections particularly in summer
	Higher summer temperatures and higher, more intense, winter rainfall may affect landfill design and operation	Monitor condition of existing landfill sites. Check design and operation of future sites with regard to climate change
Community Awareness	Climate change will impact communities	Proactively raise awareness, and provide advice and information
Business support	Climate change provides changing markets, e.g. tourism and agriculture, and demand for new products	Encourage business to adapt to new markets