Forest of Dean
DISTRICT COUNCIL

CLIMATE ACTION for Forest of Dean

Climate Change in the Forest of Dean District

Contents

Context and purpose

There is widespread scientific agreement that man-made greenhouse gas emissions are leading to rapid and potentially irreversible climate change. The threat that this poses to the UK economy has been well documented in the Stern Review, published by the Treasury at the end of last year. The Stern Review highlighted the fact that even if the world were to cease all greenhouse gas emissions tomorrow, we would still face many decades of climate change, due to the length of time that carbon dioxide stays within the atmosphere. To this end it is recognised that whilst efforts to cut emissions should continue, it is essential that we begin adapting assets, infrastructure and services to cope with the future impacts of climate change.

This report is the first climate impacts study carried out for the Forest of Dean using the most recent climate projections for the UK, UKCP09.

UK Climate Projections 2009 (UKCP09)

The UK Climate Impacts Programme (UKCIP) provides information on likely future climate change in the UK on behalf of the Government. The UK climate projections (UKCP09) have been created to help the UK to plan for a changing climate and contain information on observed and future climate change, based on the latest scientific understanding. UKCP09 builds on the data published in 2002 (UKCP02) by providing the probabilistic range of various outcomes occurring rather than one best estimate for climate changes. This probabilistic approach allows users to adopt a risk-based approach to planning and supports a more robust decision making process.

What are the projections?

The projections describe how the climate may change between now and the end of the 21st Century, based on different greenhouse gas emissions scenarios. The projections are based on the latest climate model runs and have been peer reviewed by an international group of leading experts. They do *not* include mitigation policies – i.e. global agreements to cut emissions. Because we cannot be certain about future emissions, UKCP09 uses three emissions scenarios (based on the IPCC's Special Report on Emissions Scenarios):

High – high reliance on fossil fuels;

Medium – mixed reliance on fossil fuels and new technologies;

Low – increased usage of new low emission technologies.

All of the projections in UKCP09 are representative of thirty year periods - for example the first time period is 2010-2039, representing the '2020s'. As the results are a thirty year average, UKCP09 does not give information on very near-term climate.

What do the projections mean?

UKCP09 gives a measure of the uncertainty from modelling and natural variability by assigning probabilities to different outcomes. These probabilities should be seen as a measure of the strength of evidence for different future climate changes. The probabilities allow decision makers to use the Projections when assessing climate risks. The 50% probability level is the central estimate, *i.e.* the 'likely' change, and is used for the purpose of this report.

The figures in this report summarise the anticipated changes in the Forest of Dean under the "High" and "Low" emission scenarios. While these should encompass the full range of the projected scenarios they may not necessarily represent the full range of changes that could occur.

The UK climate is already changing

Climate change is already happening as a result of human behaviour in the past. We are already experiencing climate change - globally, the ten hottest years on record have all occurred since 1997. The UK is no exception, reaching its highest ever recorded temperature, 38.5°C, in 2003. Average summer rainfall has also decreased by between 8.8 and 13.1 percent since 1961 (UKCP09). Analysis by the UK Climate Impacts Programme (UKCIP09) shows that mean daily temperatures between 1961 and 2006 rose by 1.37 °C in the South West. According to the UK Climate Projections, the changes to mean and maximum temperatures in the Forest of Dean are at the higher end of the range for those given for the whole of the South West region.

And will continue to change

These changes are set to continue into the future. For instance, average summer temperatures in the south west are expected to rise 2.7°C by the 2050s - which would make the heatwave of 2003 an average summer - but the hottest day of the year could be significantly hotter (UKCP09).

The need to adapt

Only after 2050 will efforts that are made now to reduce the emission of greenhouse gases, start to have some effect. This is because of the inertia in the earth's climate system. If global CO_2 emissions stopped tomorrow, the CO_2 already in the atmosphere would continue to drive climate change for at least the next 30 to 40 years. This means that some degree of climate change is inevitable. As a result, the county may be quite a different place within the lifetime of buildings, roads and services, which are designed and built today.

The need to adapt to climate change is increasingly being recognised through new and tightening legislation and targets, with the UK Climate Change Act becoming law in November 2008 and the European Commission publishing its White Paper on Adapting to Climate Change in 2009.

Preparing for climate change also makes good business sense, as it is about reducing risk and grasping opportunities. Being unprepared could leave the Forest of Dean District Council vulnerable to the costs, disruption and distress from extreme weather events caused by climate change. In some cases, adapting to climate change (for instance through flood resilience measures) may help to reduce our insurance premiums and could even become criteria in the future for securing adequate insurance.

The Forest of Dean District Council therefore needs to take action now, and consider its long-term plan to provide continuity of service to the people of the Forest of Dean District.

Climate change trends in the Forest of Dean

The Forest of Dean is likely to experience significant changes in climate over the coming decades. These changes can be summarised as:

Summary of projected climate change in the Forest of Dean	
Long-term / seasonal averages	Extremes
• Hotter, drier summers • Milder, wetter winters • Annual average temperature increases • Rising sea levels	• More very hot days • More heatwaves • More rain on the wettest days of the year • Summer droughts • Fewer frost nights

Figure 1: Summary of projected climate change trends for the Forest of Dean

Other trends, such as more frequent gales and reduced cloud cover in summer are predicted in some models but not others, so they cannot be treated with the same degree of confidence. The likely impacts, in particular those resulting from extreme weather events, cannot be ignored on the basis of their uncertainty, and the difficulty of predicting future weather is of itself a factor that must be considered in drawing up adaptation plans.

It is important to note that:

- Until about the middle of the century, the amount of climate change that will be experienced has largely already been set, due to emissions of greenhouse gases that are already in the atmosphere.

- The extent of changes towards the end of the century depends on present-day and future emissions:
    - the low emissions scenario assumes that global emissions will fall below today's levels by the 2080s,
    - the high emissions scenario assumes that emissions increase at a faster rate than current levels until the 2080s, by when emission rates will be approximately four times greater than today's level
- Climatologists predict some of the anticipated changes with a high degree of confidence, whereas others are less certain.

Summers will continue to get hotter and drier

There will be a significant increase in both the average (Figures 2 and 3) and maximum (Figure 4) temperatures in the Forest of Dean by the middle of the century, with particularly high temperatures in the summer months.

	low emission scenario ^{0}C	high emission scenario ^{0}C
Annual	1.9 to 2.5	2.4 to 3.2
Winter	1.5 to 2.2	2.0 to 2.7
Summer	2.0 to 3.0	2.5 to 3.7

Figure 2: Mean temperature changes (°C) in the 2050s compared to the 1961-1990 average – for the Forest of Dean. Figures indicate 'likely' range (i.e. 33%-67%) (Source of data: UKCP09)

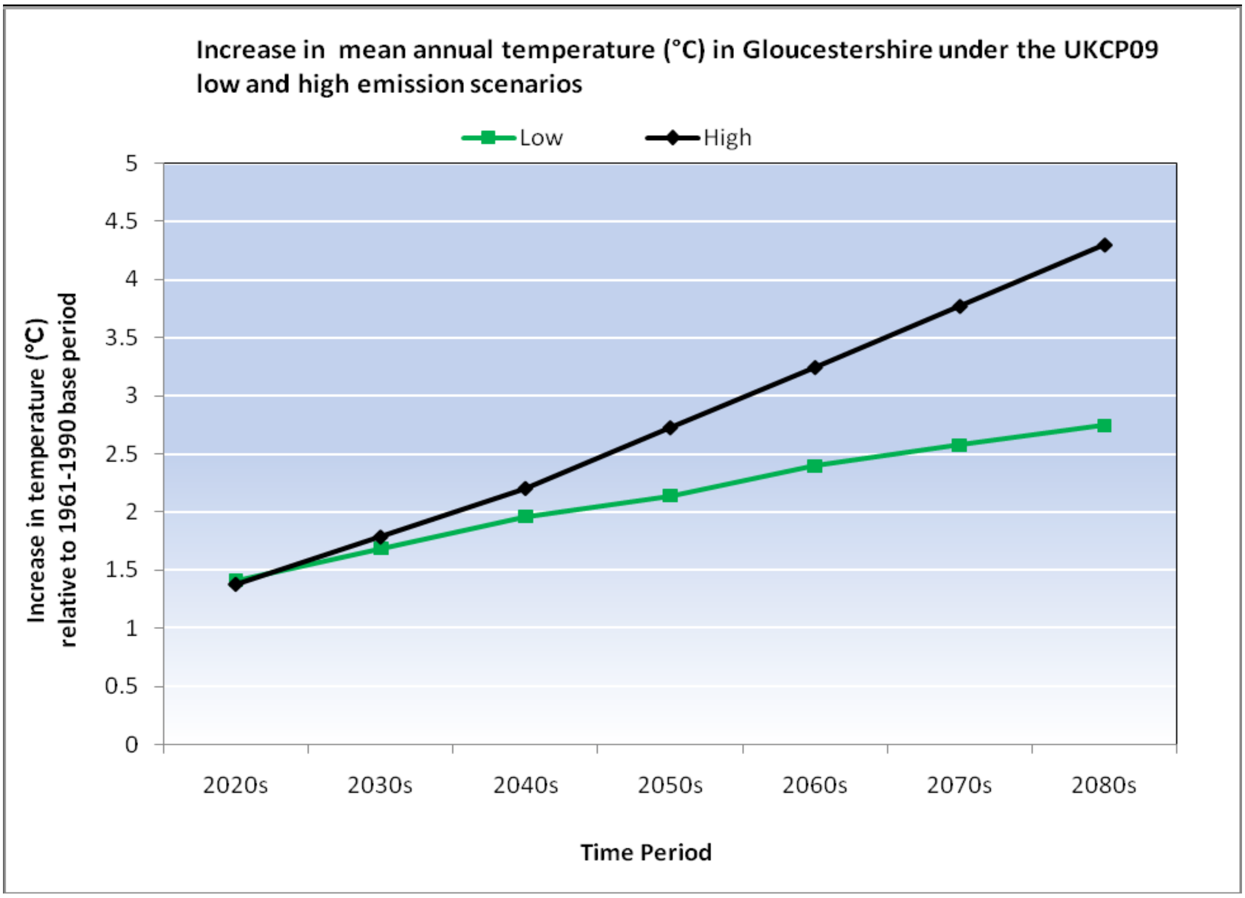

Figure 3: Increase in the Forest of Dean's mean annual temperature (50% probability level)

	low emission scenario ^0C	high emission scenario ^0C
Annual	2.0 to 2.9	2.6 to 3.7
Winter	1.4 to 2.1	1.8 to 2.7
Summer	2.5 to 4.0	3.2 to 5.0

Figure 4: Daily maximum temperature changes (°C) for the Forest of Dean in the 2050s compared to the 1961-1990 average (Source of data: UKCP09)

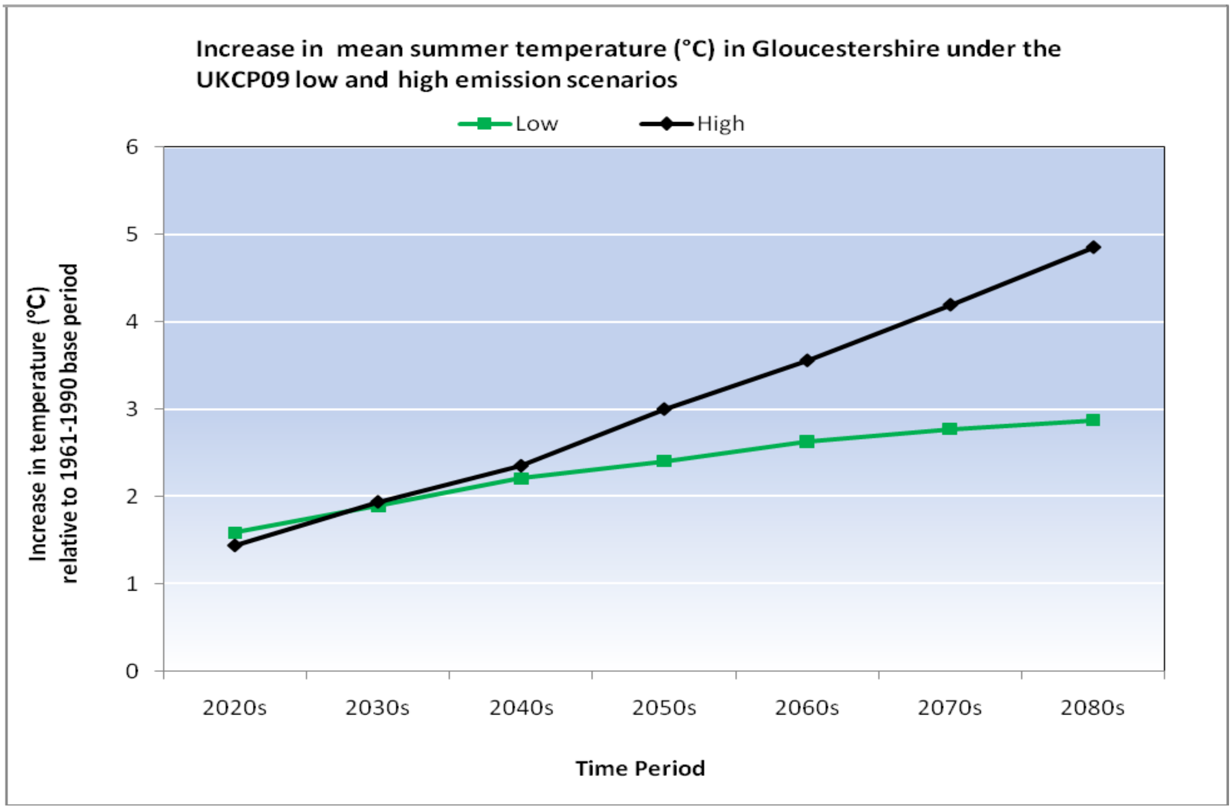

Figure 5: Increase in the Forest of Dean's mean summer temperature (50% probability level)

As Figure 5 shows, summers will become hotter and extreme high summer temperatures will become more frequent.

A combination of high temperatures and dry conditions in summer will also become more common. By the 2080s, virtually every summer, whether for the Low Emissions or High Emissions scenario, will be warmer and drier than the summer of 2003.

As the climate changes, cloud cover in summer is likely to decrease, while summer sunshine and solar radiation may correspondingly increase.

Winters will get milder and wetter

Winters are likely to become milder, with more rain. Taking the 50th percentile probability projections, models predict that average winter temperatures in the Forest of Dean will rise by between 1.8 to 2.3°C by the 2050s. This assumes that the North Atlantic thermohaline circulation, which includes the Gulf Stream, will not shut down during this period. Very cold winters are likely to become increasingly rare. Snowfall amounts will decrease significantly throughout the UK, perhaps by as much as 80 to 95 per cent in the Forest of Dean by the 2080s. While summer precipitation is likely to decrease, precipitation is projected to increase in the winter significantly and more frequent heavy rainfall events are likely. This will have a direct impact on the incidence of flooding.

	low emission scenario % change	high emission scenario % change
Annual	-1 to +2	-2 to +2
Winter	7 to 15	11 to 21
Summer	-4 to -21	-10 to -26

Figure 6: Percentage changes to precipitation in the Forest of Dean by the 2050s compared to the 1961-1990 average (Source of data: UKCP09)

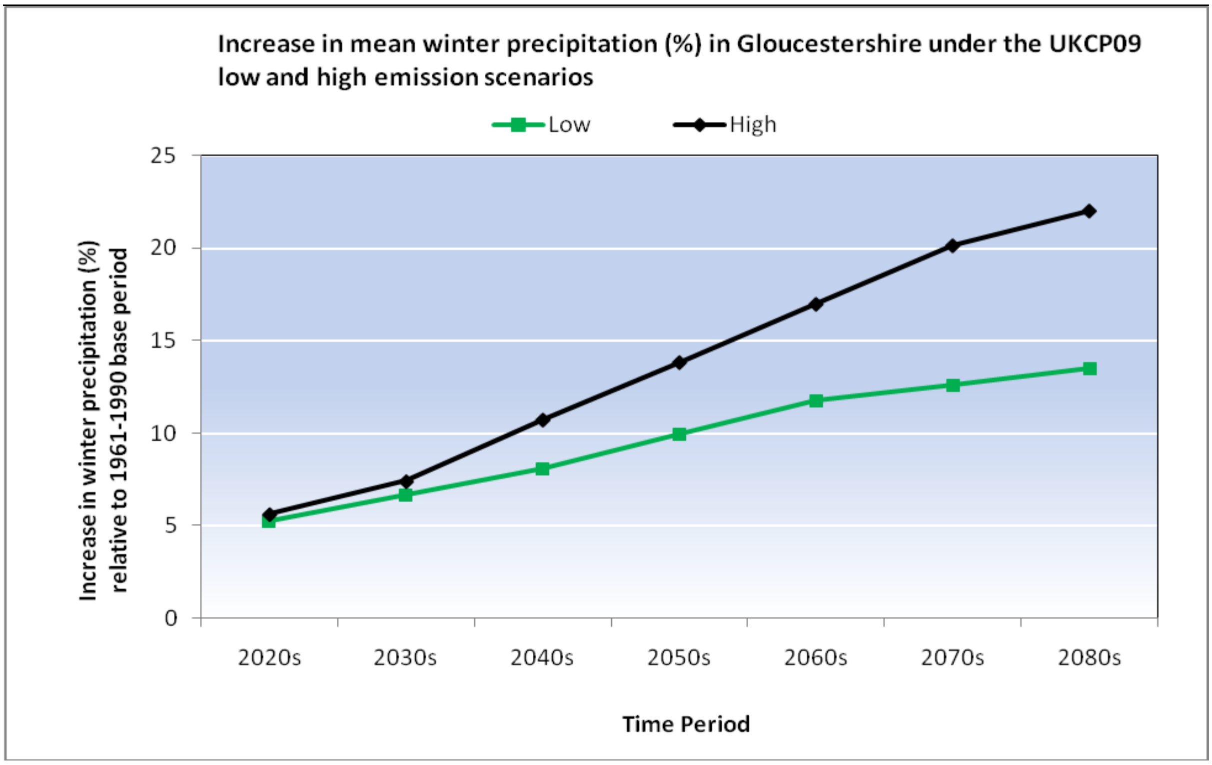

Figure 7: Increase in the Forest of Dean's mean winter precipitation (50% probability level)

Taking the 50th percentile probability projections, models predict that average summer rainfall in the Forest of Dean will fall by between 13 to 18% by the 2050s, and between 14 to 27% by the 2080s. Very dry summers like 2003 may occur in half the years by the 2080s.

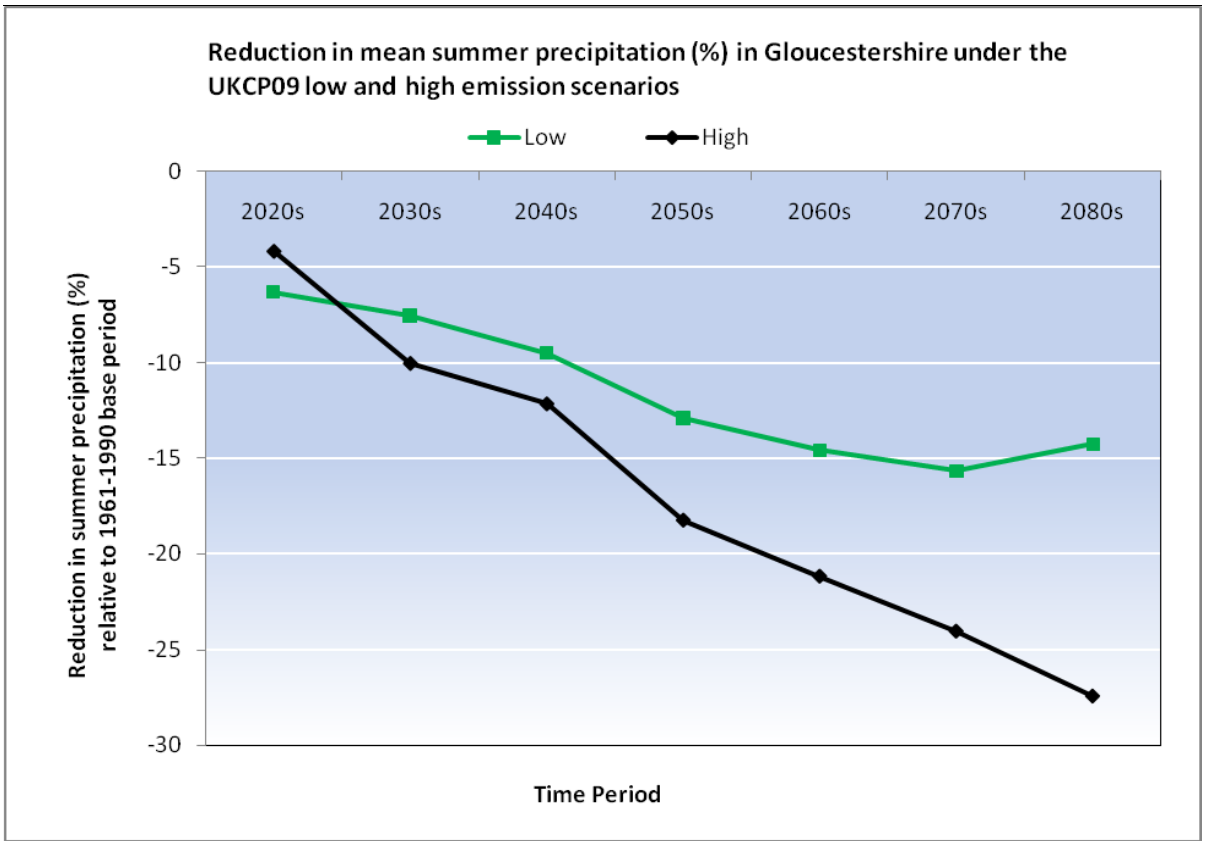

Figure 8: Decrease in the Forest of Dean's mean summer precipitation (50% probability level)

Earlier springs and later autumns

By the 2050s typical spring temperatures may occur earlier than at present and the onset of present winter temperatures may be delayed by a few weeks. This is likely to lead to a lengthening of the thermal growing season for vegetation. The amount of heating and cooling required in buildings will also change.

Extreme weather events are expected to become more common

The trends discussed above can be expected to manifest themselves over decades or years, but more extreme changes may take place over much shorter time-scales. Extreme weather events, such as flooding and drought are likely to occur more frequently in the future. Other trends, such as increased frequency of storms and gales are predicted in some models but not others, so they cannot be treated with the same degree of confidence. Nevertheless, we should be prepared for unseasonable extremes of temperature, for more violent storms and for flash flooding. By their nature these events are unpredictable, making their impact and their potential for service disruption dangerous.

Sea levels will continue to rise

The H++ (worst case) scenario for mean sea-level rise around the UK is 93 cm - 190 cm approximately by 2100. However, sea level rise projections carry large uncertainties. It is likely that current estimates are too conservative as the latest scientific research suggests the Greenland and West Antarctic Ice Sheets are more vulnerable to global warming than first anticipated. Were both ice sheets to melt completely this would increase global sea levels by 12m.

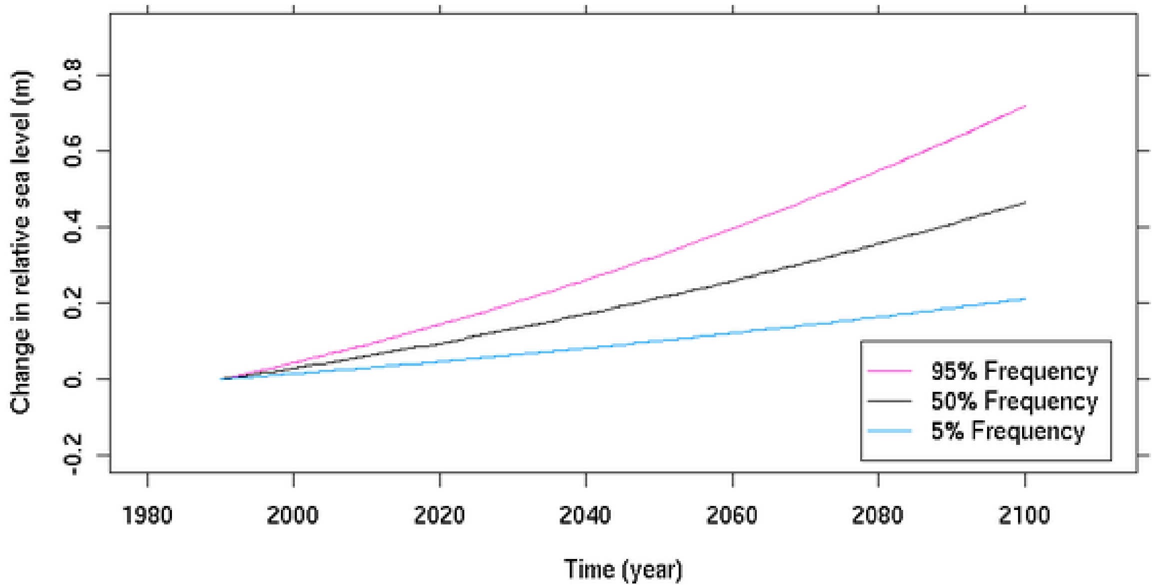

Figure 9: Sea level rise projections for the Forest of Dean coast during the 21st Century

Storm Surge Height

The coast around the Forest of Dean and the South West could experience an increase in 50-year return surge height of up to 0.08m (on top of sea level rise) by the 2080s.

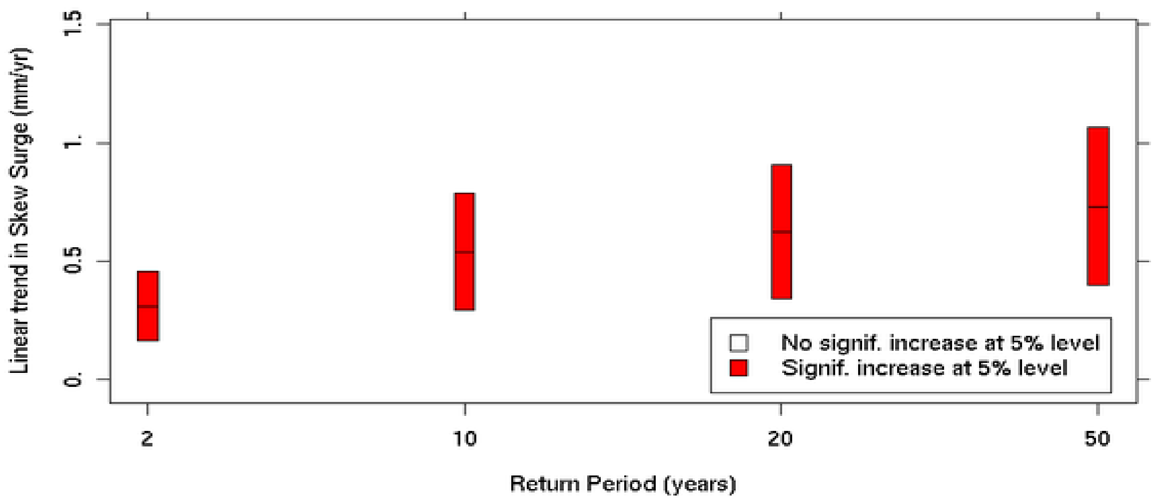

Figure 10: Returns plot showing linear trend in storm surge height for the Forest of Dean coast during the 21st Century

Sea Level Rise and Flooding

Climate change impacts on flooding and coastal erosion are a challenge and risk for the Forest of Dean. These impacts include sea level rise and the potential increase in intensity, severity and frequency of coastal storms, and rainfall events affecting fluvial catchments and urban surface water systems. The most common cause of flooding in the rivers in the Forest of Dean that flow into the Severn is tide locking. This occurs when storms coincide with high tides and the tributaries are unable to discharge into the River Severn.

The main flood defences in the Severn Tidal Tributaries catchments are embankments and tidal outfall flaps. Modelling undertaken to inform the Catchment Flood Management Plan (CFMP) (Environment Agency 2007) assumes sea level rise of 250mm by 2050 and increased river flows of +20% in all the main rivers flowing into the Severn. When these climate change factors are then added to anticipated urban development and changes in the land use; the modelling shows a significant increase in the potential damage caused to property and farmland from a 1 in 100 year flood event.

Other Climate Variables

In addition to the temperature, precipitation and sea level variables discussed above, UKCP09 gives changes in a number of other variables. We summarise here changes in some of the most commonly used of these, by the 2080s under Medium emissions; projections are for the 50% probability level:

Short-wave radiation: Downward at the surface shows changes of only a few percent in winter. In summer it increases by up to +16 Wm-2 (–2 to +37 Wm-2) in the Forest of Dean.

Cloud cover: Total cloud amount changes by only a few percent in winter. It decreases in summer, by approximately 18% (central estimate).

Humidity: Specific humidity - the absolute amount of moisture in the atmosphere - will increase throughout the year, and relative humidity will decrease in summer by as much as about 10% (central estimate).

For a variety of different reasons it has not been possible in UKCP09 to provide probabilistic projections of future changes to wind speed, soil moisture, or snowfall.

Wind speed: Although probabilistic projections for changes in wind speed in the UK have not been provided in the UKCP09, a Met Office Regional Climate Model (RCM) has modelled changes in winter-mean wind speed. Results shown in Figure 20, Annex 5 indicate that changes in winter wind speed in the UK will most likely be small.

Snowfall: Reduction in snowfall in the Forest of Dean by 65–80% over mountain areas and 80–95% elsewhere (see Figure 20, Annex 5).

Storm tracks: Differences exist between the climate models on storm tracks, meaning that robust projections of changes in storm track are not yet possible.

Anticyclones: There is no compelling evidence that the frequency, duration or intensity of depressions affecting the UK will change markedly either way, although neither can it be ruled out.

Summary

	Mean Summer Temperature (˚C)			Summer Rainfall (%)			Winter Rainfall (%)			Sea level Rise (m)		
	High	Med	Low	High	Med	Low	High	Med	Low	High	Med	Low
2020s	1.5	1.6	1.6	-4.1	-7.0	-6.2	6.3	5.4	5.8	0.11	0.10	0.08
2030s	2.0	2.0	1.9	-9.9	-9.0	-7.4	8.3	7.9	7.4	0.16	0.13	0.11
2040s	2.4	2.3	2.3	-12.0	-12.3	-9.4	12.0	11.2	9.0	0.20	0.17	0.15
2050s	3.1	2.8	2.5	-18.0	-17.6	-12.7	15.4	13.7	11.1	0.26	0.21	0.18
2060s	3.7	3.1	2.7	-20.9	-19.6	-14.4	19.0	16.0	13.1	0.31	0.26	0.22
2070s	4.3	3.5	2.8	-23.7	-20.8	-15.4	22.5	16.6	14.1	0.37	0.31	0.26
2080s	5.0	3.9	2.9	-27.1	-21.5	-14.1	24.6	18.4	15.1	0.43	0.36	0.30

Figure 11: Summary of the 'likely' (50th percentile projections) climate impacts for the Forest of Dean until the end of the 21st century

Climate Variable Likely change by around the 2050s

Relative to 1961-1990 base period, using 50% probability level for the low and high emissions scenario data from UKCIP09.

Temperature

- Annual warming 2.2 to 2.8°C (2.8 to 4.4 degrees Celsius by 2080s)
- Greater night-time than day-time warming in winter
- Greater day-time than night-time warming in summer
- Summer warming 2.5 to 3.1°C (3.0 to 5.0 degrees Celsius by 2080s)
- Summers as warm as 2003 become more common
- Annual warming 2.2 to 2.8°C (2.8 to 4.4 degrees Celsius by 2080s)
- Greater night-time than day-time warming in winter
- Greater day-time than night-time warming in summer
- Summer warming 2.5 to 3.1°C (3.0 to 5.0 degrees Celsius by 2080s)
- Summers as warm as 2003 become more common

Precipitation

- Winters 11 to 15% wetter (15 to 25% wetter by 2080s)
- Summers 13 to 18% drier (14 to 27% drier by 2080s)
- Heavy rainfall events in winter become more frequent and intense
- Greater contrast between summer (drier) and winter (wetter) seasons
- Winter and spring precipitation becomes more erratic
- Amount of snowfall decreases significantly (80 to 100% reduction)
- Summers as dry as 1995 (37% <average rainfall) become more common

Cloud Cover

- Reduction in summer and autumn cloud, and an increase in radiation
- Small increase in winter cloud cover

Humidity

- Specific humidity increases throughout the year
- Relative humidity decreases in summer

Soil Moisture

- Projections for soil moisture are not available in UKCP09.

Storm Tracks

- Robust projections of changes in storm track are not yet possible.

North Atlantic Oscillation (NAO)

- The Intergovernmental Panel on Climate Change (IPCC) assessment concluded that the most recent models showed a trend towards positive NAO but with considerable spread among the climate models. A more positive NAO will cause wetter, windier and milder winters.

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Climate Variable Likely change by around the 2080s

If we continue under a medium emission trajectory, by the 2080s we are likely to see:

Summer

- An average daily maximum temerature 5.1°C greater than 1961-1990 average.
- Mean summer temperature expected to rise by 3.9°C.
- Warmest day is likely to be 3.5°C hotter.
- On average summer is likely to be around 22% drier.

Winter

- An average daily maximum temerature 2.7°C greater than 1961-1990 average.
- Mean winter temperature expected to rise by 2.9°C.
- Coolest day is likely to be 2°C milder.
- On average winter is likely to be 18.4% wetter.

Annual

- A negligible change in average annual rainfall (+0.6% wetter).
- Sea-level rise of around 0.4m.

We will need to understand the specific risks of these climatic factors and changes in each aspect of our estate and services.

Appendices

Appendix 1 – SRES Scenarios

Developed for use by the Intergovernmental Panel on Climate Change (IPCC) in the Fourth Assessment Report, the SRES emission scenarios cover a wide range of the main driving forces of future emissions, from demographic to technological and economic developments. As required by the Terms of Reference, none of the scenarios in the set includes any future policies that explicitly address climate change, although all scenarios necessarily encompass various policies of other types. These 3 SRES scenarios (low, medium and high) are the primary scenarios used in the UC Climate Projections 09.

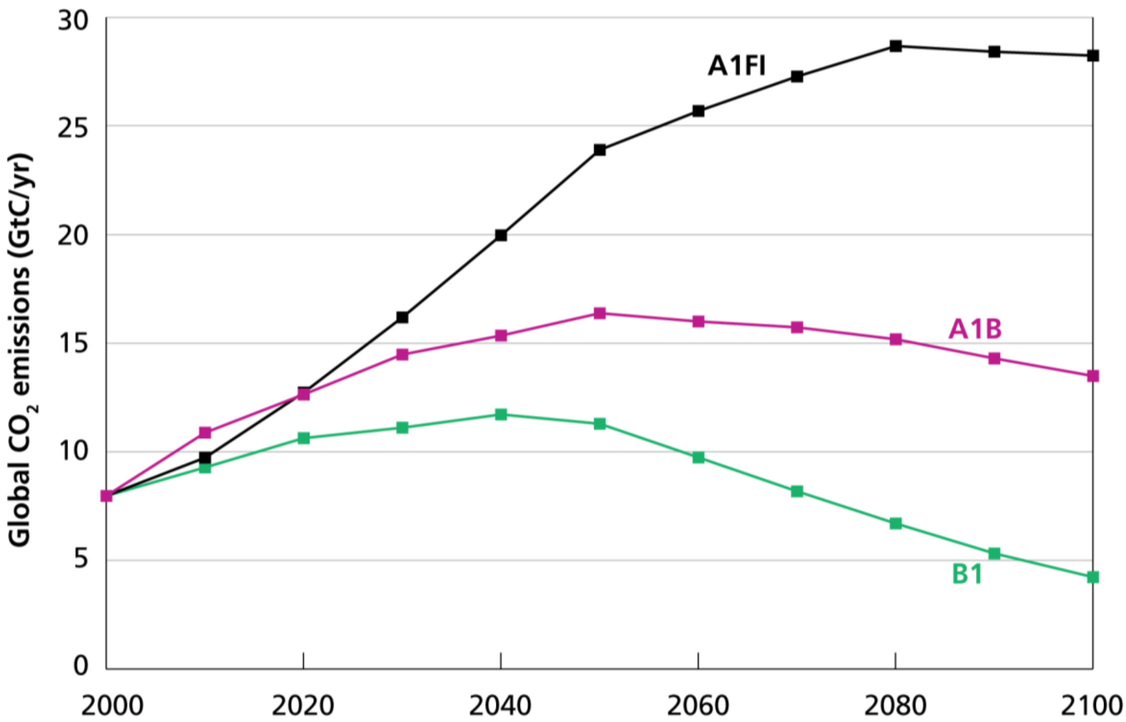

Figure 12: CO_2 emissions under the three IPCC SRES scenarios used in UKCP09: A1FI (black: High emissions), A1B (purple: Medium emissions) and B1 (green: Low emissions). (Source: IPCC, 2007)

Appendix 2 – Probability levels

UKCP09 gives a measure of the uncertainty from modelling and natural variability by assigning probabilities to different outcomes. This is explained in Figure 15 below:

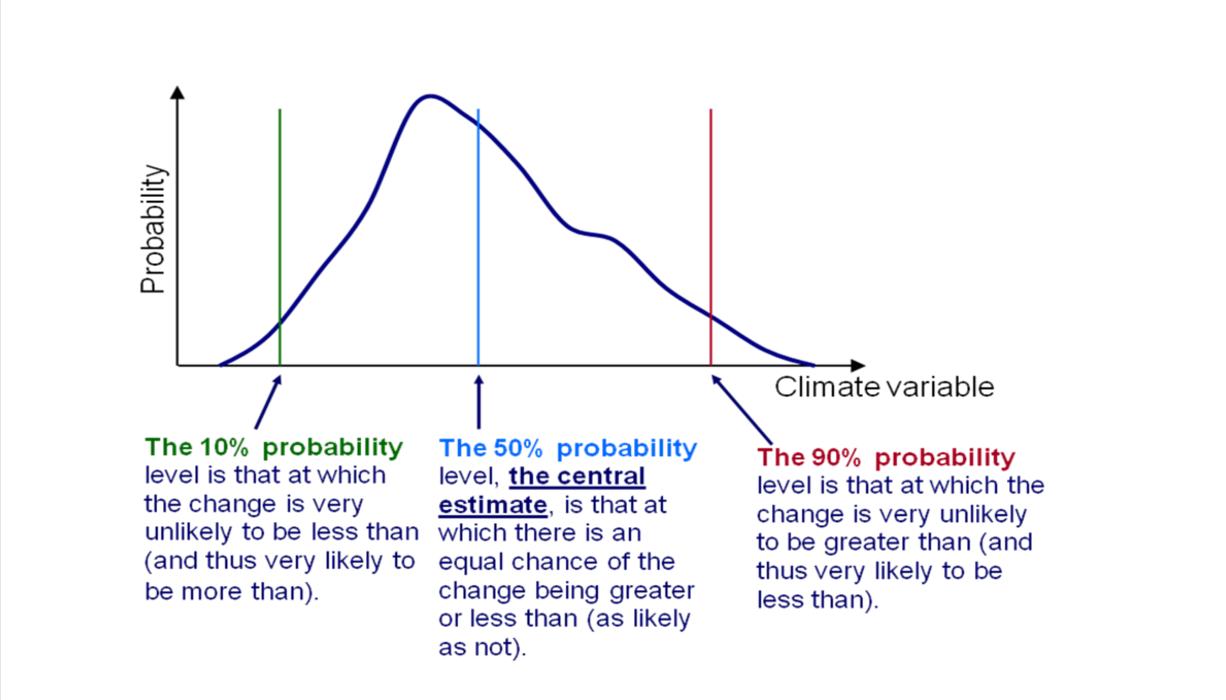

Figure 13: Explaining nature of UKCP09 probabilistic outcomes

For the purpose of this report the where there is a single figure representing a projection the central estimate (50% probability level) has been used, and where a range is given then the central or 'likely' band (33- 67% probability level) has been used.

Probability Level	Description
< 10%	very unlikely to occur
33% - 67%	likely to occur
>90%	very unlikely to occur

Figure 14: Breakdown of probabilistic outcomes used in UKCP09 and what they actually mean.

Appendix 3 - Precipitation

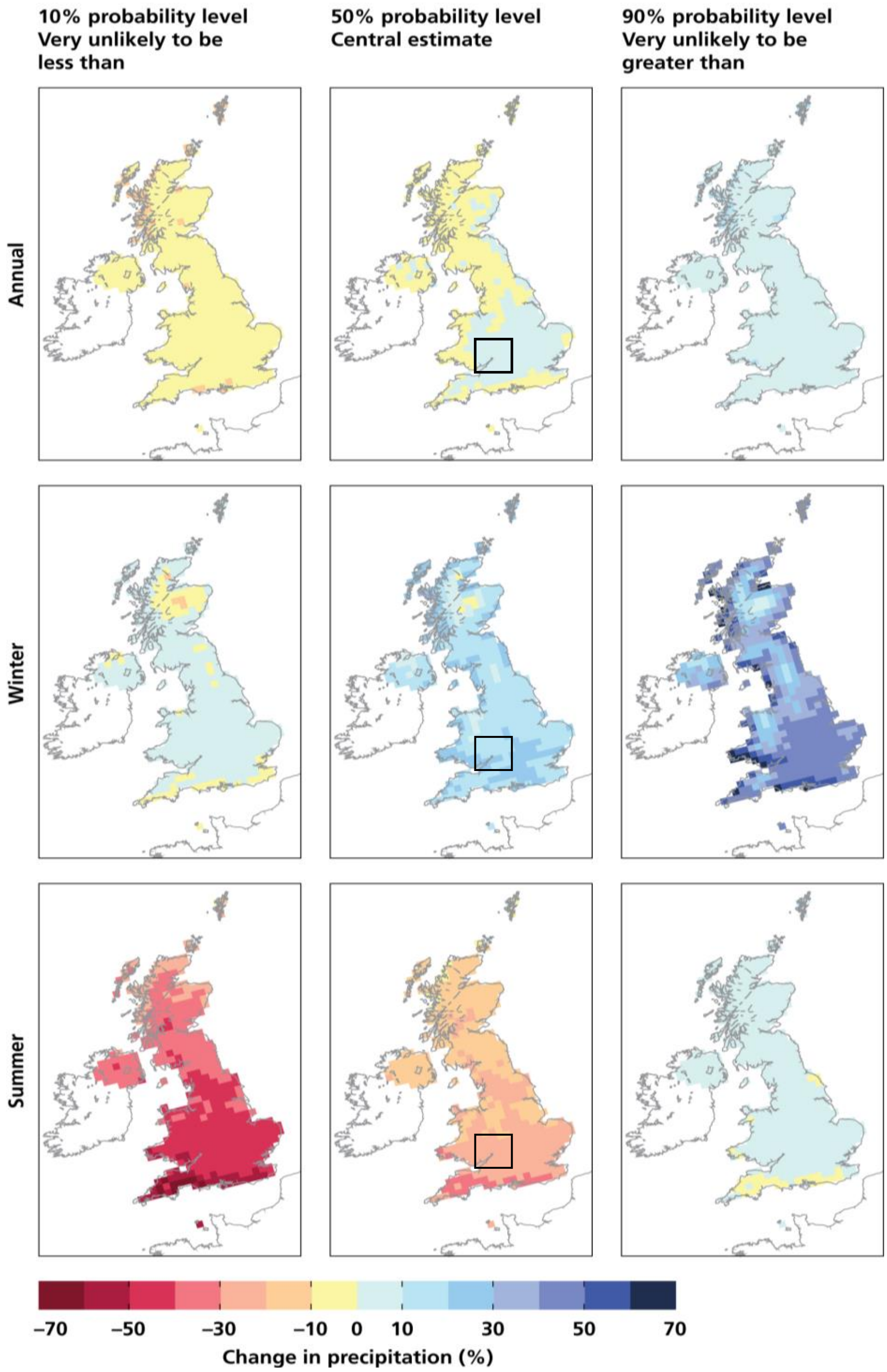

Figure 15: Changes (%) in annual (top), winter (middle) and summer (bottom) mean precipitation at the 10, 50 and 90% probability levels, for the 2080s under the Medium emissions scenario. (Source: UKCP09 Report)

Appendix 4 – Temperature

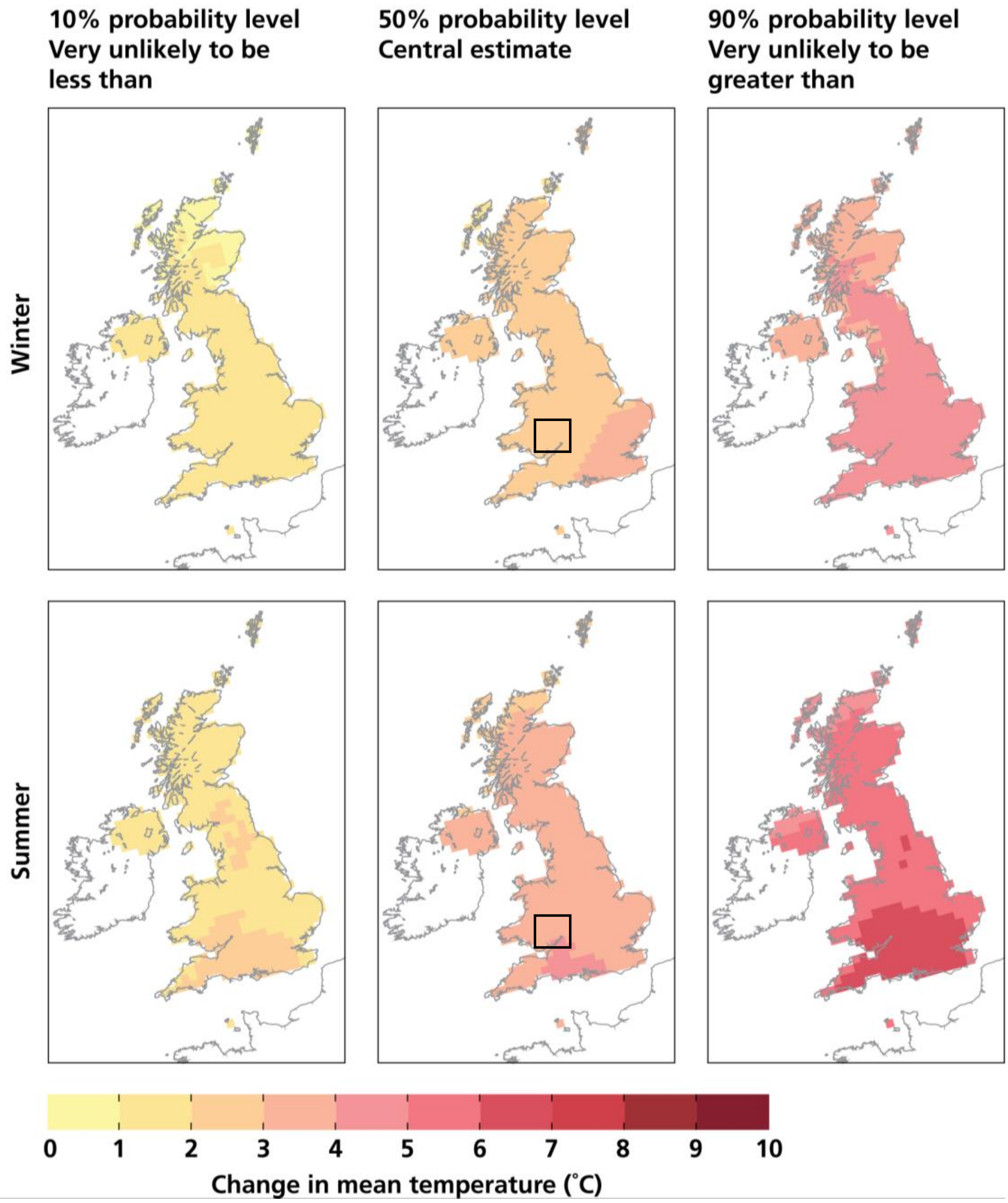

Figure 16: 10, 50 and 90% probability levels of changes to the average daily mean temperature (°C) of the winter (upper) and summer (lower) by the 2080s, under the Medium emissions scenario. (Source: UKCP09 Report)

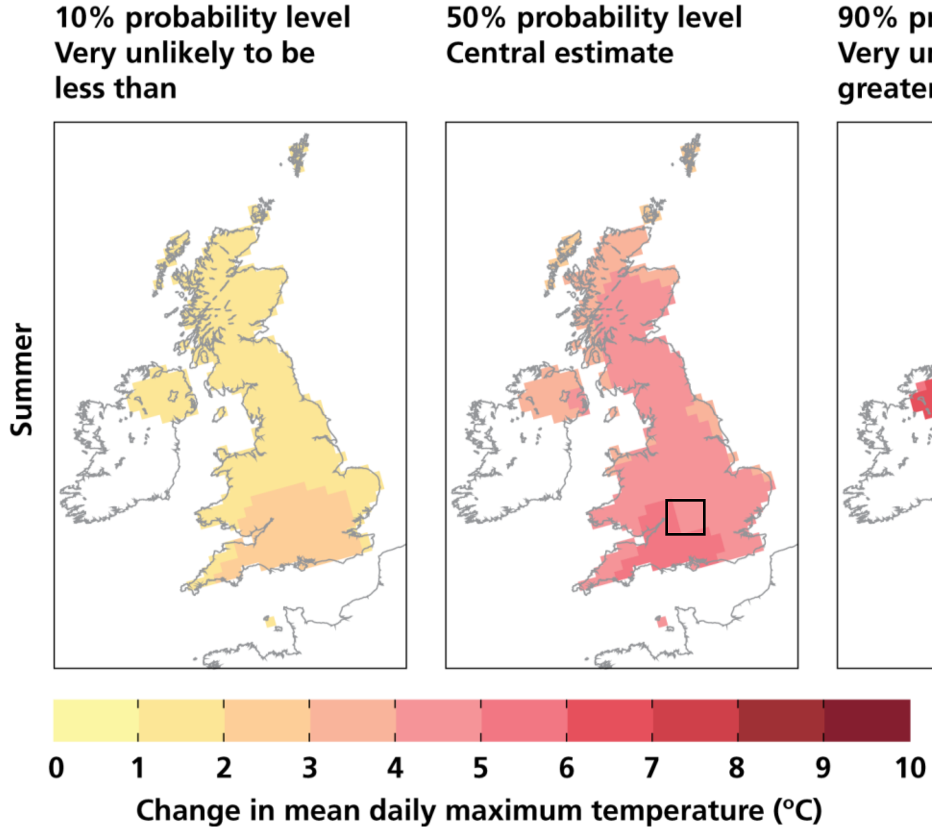

Figure 17: 10, 50 and 90% probability levels of changes to mean daily maximum temperature in summer, by the 2080s, under the Medium emissions scenario. (Source: UKCP09 Report)

Appendix 5 – Wind speed and snowfall

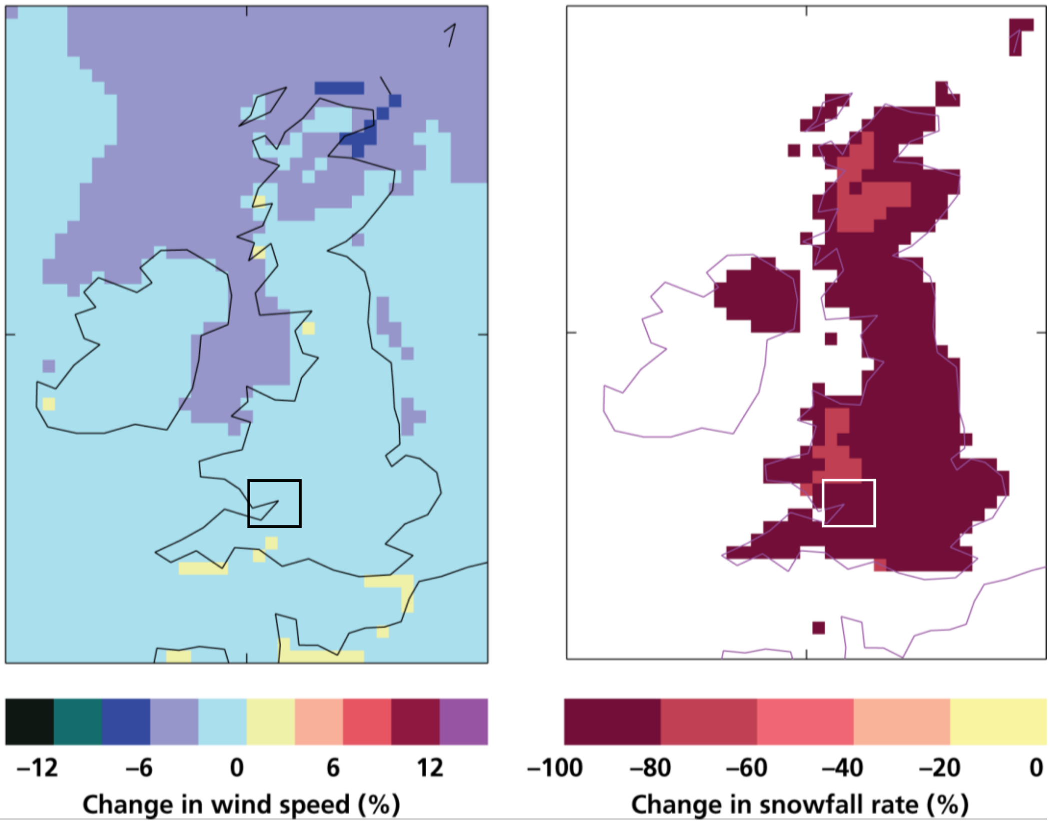

Figure 18: Percentage changes in mean wind speed in winter (left) and mean snowfall rate in winter (right), by the 2080s (relative to 1961–1990) under the Medium emissions scenario, averaged over the 11 members of the Met Office Hadley Centre RCM ensemble.

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Appendix 6 – Detailed Summary

Changes in climate hazards	Relative confidence level	Changes in the Forest of Dean	
		Low emissions scenario	High emissions scenario
Increasing summer temperatures	High	2020s: 1.3 to 2.0°C 2050s: 2 to 3 °C 2080s: 2.4 to 3.6°C	2020s: 1.1 to 1.8°C 2050s: 2.5 to 3.7°C 2080s: >4°C
Increasing winter temperatures	High	2020s: 1.0 to 1.5°C 2050s: 1.5 to 2.2°C 2080s: 2.1 to 2.9°C	2020s: 1.0 to 1.5°C 2050s: 2.0 to 2.7°C 2080s: 3.0 to 4.0°C
More frequent extreme high temperatures	High	Increase of 60 or more 'hot'[a] days in summer by the 2080s[c]	
Less extreme low temperatures	High	Fewer frost days, long runs of snow less winters	
Increasing winter rainfall	High	2020s: 3 to 9% 2050s: 7 to 15% 2080s: 10 to 20%	2020s: 3 to 10% 2050s: 11 to 21% 2080s: 18 to 33%
Reducing summer rainfall	Medium	2020s: 0 to 12% 2050s: 4 to 21% 2080s: 6 to 22%	2020s: 2 to 10% 2050s: 10 to 26% 2080s: 17 to 37%
Increases in winter precipitation intensity	High	By the 2080s, 15% increase in precipitation on the wettest day, which can be exceeded, on average, once every 2 years(b)(c)	By the 2080s, 20%+ increase in precipitation on the wettest day. which can be exceeded, on average, once every 2 years(b)
Potentially an increase in frequency and intensity of winter storms	Low	There is no compelling evidence from models that the frequency, duration or intensity of storms or depressions affecting the UK will change, although neither can it be ruled out. Percentage changes in mean winter wind speeds by the 2080s are negligible.	
Increased frequency of dry spells (10+ consecutive dry days)	High for summer changes	Double the number of dry spells in 2080s, though likely to be exceeded every 1 in 2 yr	

Changes in climate hazards	Relative confidence level	Changes in the Forest of Dean	
		Low emissions scenario	High emissions scenario
Sea level rise [(d)]	Medium	2020s: 0.8m 2050s: 0.18m 2080s: 0.3m	2020s: 0.11m 2050s: 0.26m 2080s: 0.34m
Increasing storm surge height	Low	Coast around the South West could experience an increase in 50-year return surge height of up to 0.08m (on top of sea level rise) by the 2080s	
(a) 'Hot' days are defined as exceeding 25°C (b) 50% probability level used i.e. likely to be exceeded every 1 in 2 yr. (c) This data only available for the 2080s in the UKCP09. (c) Relative sea level rise in metres, for 50th percentile probability level			

Figure 19: Detailed summary of climate change projections for the Forest of Dean

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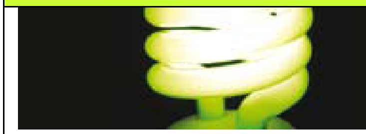
Appendix 7 – How we will need to adapt

Many aspects of our lives and lifestyles will be affected by climate change.

How we'll need to adapt

We can adapt to reduce the impact of many, but not all, of these changes.

		Energy	Water
			
Extreme Weather		The Forest of Dean's energy infrastructure is at risk from extreme weather, such as flooding and heat waves.	Wetter winters, and storm surges combined with sea-level rise, will increase flood risk in the Forest of Dean.
High Temperatures		Hotter summers will increase the demand for air conditioning; less heating will be needed in winter. Power cables underperform when it is hot.	Higher temperatures could cause water demand to rise.
Drought		Many power stations use water from rivers to cool their turbines – less water will be available, increasing competition with other water users.	Droughts will increase current pressure on water demand, supply and quality – including in the UK.
Floods		Some power stations are situated in flood risk zones and near the coast, so future planning will need to account for predicted sea-level rise and heavy rainfall events.	Sewage flooding could increase due to more heavy rainfall.
Urban Heat Island		Towns and urban areas tend to be much warmer than their surroundings. Peaks in electricity demand due to air conditioning occur during summer heat waves.	Higher urban temperatures will increase water consumption, including demand associated with cooling buildings and watering gardens & parks.

Built Environment	Transport	Agriculture
		
Buildings will have to withstand more extreme weather — increased temperatures and rain.	Increased temperatures and rain will have a big effect on road and rail networks in the UK.	Extreme weather, such as storms or heat waves, can cause major damage to crop yields.
People will be more vulnerable to heat stress caused by increased temperatures and humidity.	Road surfacing will melt unless replaced with different materials.	Higher year-round temperatures could allow new crops to flourish in the UK. Diseases and pests could survive milder UK winters.
Drier soils lead to subsidence – foundations may have to be very deep to reach more secure soil.	Subsidence caused by changes in soil-moisture content may lead to more frequent and expensive repair of infrastructure.	Droughts could reduce our crop yield and increase demand for irrigation. Many UK potato varieties are not drought tolerant.
The location of building projects, drainage and flood resilient construction will be increasingly important.	Coastal roads and railways are threatened with wetter winters, intense rainfall, coastal erosion and sea-level rise.	More heavy rain will lead to increased risk of flooding. This will wash out nutrients and lead to water logging of fields.
Reflective roof coverings and light-coloured building materials can help combat over-heating in cities.	Summer temperatures, which can already reach uncomfortable levels on public transport systems, are set to increase.	Higher winter temperatures in towns can support the life cycle of some non-native agricultural pests that can spread into rural areas.

Figure 20: How we will need to adapt to climate change

Appendix 8 – Direct Climate Impacts

Climate Variable	Specific climate changes and impacts	Direct impacts
Warmer temperatures	Declining number of days requiring heating	Reducing heating requirements in buildings
	Increasing number of days requiring cooling	Increasing need for cooling systems in existing buildings and incorporation of measures to provide cooling in new buildings
	Increasing frequency of very warm summers and very warm days	Increased Tourism Increased Heat stress - Risks to vulnerable people Infrastructure risks Risks to biodiversity Heat related deaths Risk to Food Security Increasing need for cooling systems in existing buildings and incorporation of measures to provide cooling in new buildings
	Lengthening of the growing season	Increasing requirements to manage green spaces, verges etc over longer period Changes to crops and biodiversity
Precipitation	Drier summers	Pressure on water resources Reduced stream flow and water quality Increased drought Subsidence Decreased crop yields
	Wetter winters with less snow	Increased risk of flooding Increased subsidence Risks to urban drainage Severe Transport disruption Reduced requirement for snow clearing of roads
	Increasing frequency of extreme rainfall events	Increased risk of flash floods Increased risk of water penetration of buildings

Climate Variable	Specific climate changes and impacts	Direct impacts
	Increasing frequency of very dry summers	Increased risk of droughts and water shortages Increased risk of long-term damage to some tree species
Cloud cover	Reduction in summer cloud and an increase in short-wave radiation	Increased risk of harmful solar radiation causing skin cancers Increasing need for shading in buildings and open spaces
Humidity	Increases in specific humidity throughout the year	Increased heat stress to vulnerable adults, children, animals Increase in damp in poorly ventilated buildings
Wind/storms	No UKCP09 probabilistic projection available. Some models suggest a possible increase in frequency of winter depressions and hence high winds/ storms in winter	Potential damage to buildings and other infrastructure
Sea level rise and storm surges	Up to 26cm rise in sea levels in the Severn estuary by 2050	Increasing risk of 'tide locking' on rivers flowing into the Severn and consequent flooding Loss of salt marsh & wetland habitats
	Increasing storm surge height and increased frequency of storm surges	Increasing risk of 'tide locking' on rivers flowing into the Severn & consequent flooding

Figure 21: Direct impacts of climate change on the Forest of Dean

Forest of Dean
DISTRICT COUNCIL

www.fdean.gov.uk

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