ClimateSouthWest

Warming to the idea

Building resilience to extreme weather and climate change in the South West

Climate SouthWest Summary Report (2010)

Sponsored by ENVEC www.oursouthwest.com SOUTH WEST WATER

Foreword

"The South West is considered a special place by both residents and visitors alike. But it is already impacted by extreme weather events which seriously damage property and threaten lives. This will only get worse as our climate changes. Since 'Warming to the Idea' was first written in 2003, great work has been done to look at how climate change will affect our way of life – both for better and for worse. We have deepened our understanding of the impacts of climate change and have made positive steps in identifying and implementing actions to prepare for these.

Planning for climate change has to be an ongoing process. There is still much to be done in ensuring that our landscape, businesses, local communities and infrastructure are resilient to the challenges that lie ahead. We should also recognise the emerging opportunities. Climate change can offer many benefits, as long as we are aware of the accompanying challenges and remain proactive.

Adapting to the impacts of climate change will be tough but I am confident that, by working together and planning ahead now, we can make sure the South West continues to be a fantastic place to live and work."

Richard Cresswell
Chair of Climate SouthWest
and Environment Agency Director South West
November 2010

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Introduction

Extremes of weather already cause serious damage and loss of life. Climate change will increase the frequency and severity of these impacts. The Intergovernmental Panel on Climate Change (IPCC) states that 'warming of the climate system is unequivocal' and that most of the warming since the mid-20th century is very likely due to human activities[1]. It is, therefore, crucial that we take action to reduce the causes of climate change. It is also vital to prepare for the impacts of extreme weather and sea level rises.

Here in the South West, the change in climate is already starting to bring both opportunities and challenges, and will continue to bring new ones in the coming decades. For instance, fishing crews are seeing new species in their nets and farmers are already able to grow new crops. On the down side, severe flooding is happening more often, water resources are stretched and some plant and animal species are coming under increasing pressure.

Planning and preparing for our changing climate is crucial in order to ensure that the South West's communities, economy and environment are as resilient as possible and that we make the most of emerging opportunities.

In 2003, Climate SouthWest (then known as the South West Climate Change Impacts Partnership) commissioned a scoping study, 'Warming to the Idea: Meeting the challenges of climate change in the South West'. The study investigated the likely impacts of climate change on the South West and set out what needs to be done to adapt.

This report updates the original 'Warming to the idea' summary report. It reflects recent developments in climate science, as well as an improved understanding of key issues, priorities and adaptation opportunities for the South West.

This report from key stakeholders in the South West is a refreshed call for action. It summarises the likely impacts of climate change on key sectors in the South West, and suggests what needs to be done to adapt.

"Adaptation is the only means to reduce the now-unavoidable costs of climate change over the next few decades" Sir Nicholas Stern, 'The Stern Review' on economics of climate change, October 2006

Although the report is structured by key themes and sectors, each one should not be considered in isolation, as there are multiple interdependencies between them.

The full, technical report of 'Warming to the Idea' is available to download from the Climate SouthWest website at www.oursouthwest.com/climate.

The main aims of the 2003 study were to:

- describe the climate change scenarios projected for the South West in the coming century;
- identify the likely impacts of such change;
- suggest actions to respond to the challenges and opportunities presented by these impacts.

The study is still a valuable resource to help us all plan for the future and adapt to the South West's changing climate.

Climate SouthWest will continue to take forward the messages from the study and encourage them to be built into decision-making within the South West.

Wells Cathedral © Phil Harding www.oursouthwest.com

Coastal Flooding St.Ives

[1]IPCC Fourth Assessment Report: Climate Change 2007 (Synthesis Report: summary for policymakers - p2 & 5)

The South West – a special place

A great diversity in landscapes, wildlife, cultural heritage and economic activity makes the South West a special place to live, work or visit.

Over five million people live in the South West[2], which includes Gloucestershire, Bristol, Wiltshire, Dorset, Somerset, Devon, Cornwall and the Isles of Scilly. Each year 21 million tourists visit the region, contributing £4.1 billion to its economy[3].

Residents and visitors alike enjoy the South West's beaches and moors, its wildlife and famous gardens, its thriving cities and rolling farmland. Yet every aspect of our life faces an uncertain future because of extreme weather and climate change. Sector by sector, this report details the likely impacts of climate change during the 21st century.

The South West must address risks such as increased flooding and uncomfortably hot working environments, whilst making the most of opportunities such as an extended growing seasons and the scope for increased outdoor activities.

Stockhill Priddy, Somerset © Mark Durk, 2008, www.oursouthwest.com

Durdle Door, Dorset
© Elizabeth Cooksey, 2010, www.oursouthwest.com

Stourhead, Wiltshire
© Phil Harding www.oursouthwest.com

[2]Office for National Statistics (2007)
[3]UK Tourism Survey 2009

Key messages for the South West

- We are already vulnerable to extreme weather. Climate change will make this worse. We need to plan for both current and future vulnerability.
- Further climate change is inevitable and unavoidable. Planning for the impacts will be more cost-effective than reacting to them.
- Most individuals are aware of extreme weather and climate change but this does not always extend to an understanding of the impacts and how to adapt.
- Extreme weather and climate change impacts should be integrated into planning, policy and decision-making at all levels.
- Adaptation should be viewed as part of normal business practices (e.g. Business Continuity and Risk Management processes).
- Greater opportunities exist for those businesses that are resilient and able to adapt. For example, opportunities for new markets exist in tourism and leisure, outdoor activities, food and drink and renewable energy.

Climate change is happening now in the South West and we are already vulnerable to extreme weather.
We need to plan for both current and future vulnerability

Our changing climate

The Global Picture

There is no doubt that our climate is changing. The Earth has been warming up – globally, average temperatures have risen by more than 0.7°C over the last 100 years[4] and the 'noughties' (2000 – 2009)[5] was the warmest decade on record.

Warming over the last 50 years is very likely to be largely man-made, caused by increases in the atmosphere of heat-trapping greenhouse gases, such as carbon dioxide and methane. As greenhouse gases increase, less heat can escape back into space - enhancing the natural greenhouse effect and making the Earth warmer.

Almost 100 parties have ratified or acceded to the Kyoto Protocol, which sets legally binding targets for 37 industrialised countries and the European community for reducing greenhouse gas emissions by 2012. Although a legally binding successor to the Kyoto Protocol has not been agreed, the Copenhagen Accord (agreed at the 2009 UN Climate Summit in Copenhagen) endorses the limit of 2°C as the threshold for dangerous climate change and expresses a 'strong political will' to tackle it.

However, regardless of action taken to curb emissions, some changes are now unavoidable due to past emissions already in the climate system. This means that the actions we take now will only make a real difference to reducing climatic change beyond the 2040s. Therefore, it is essential that we prepare for the changes that are now inevitable, as well as cut emissions to limit warming in the future.

Observed climate changes[6]

Between 1961 and 2006, average daily temperature in the South West increased by 1.37°C, with the number of days of air frost decreasing by 20.9 days. There have also been several instances of extreme high temperatures in recent years – 10th August 2003 saw the hottest ever maximum temperature in the UK (38°C at Faversham in Kent), and in July 2006 temperatures across southern England were higher than in Spanish resorts such as Ibiza and the Canary Islands.[7]

Annual precipitation also increased between 1961 and 2006, with the largest increase seen in autumn (28.6%). In summer, however, there was a small decrease in total precipitation (8.8%). In addition to changes in the seasonality of precipitation, there have also been changes to its characteristics – for instance, the contribution to total winter precipitation from heavy precipitation increased by approximately 5%. These changes in characteristics have big implications in terms of increasing the instances of droughts and floods.

Absolute sea level (i.e. corrected for land movement) around the South West has risen by around 1 mm/yr over the 20th century, and there are indications that the increase has been at a faster rate than this in the 1990s and 2000s. The nature of land movement in the South West (where land levels are generally getting lower through time) is likely to enhance the effect of rising sea levels, exacerbating issues of coastal flooding and erosion.

[4] Climate Change – the big picture (Met Office 2008)
[5] 'Noughties' confirmed as the warmest decade on record' (Met Office 2009)
[6] State of the South West's Environment 2010 (South West Observatory Environment Network 2010)
[7] 'Roads melt as temperatures soar' (BBC news article, 2006)

Our changing climate

The South West Picture

In 2009, the UK Climate Impacts Programme (UKCIP), the Met Office and the Department for Environment, Food and Rural Affairs (Defra) released the UK Climate Projections 2009 (UKCP09). These projections provide information on the possible climate over the course of the 21st Century and are based on three different future scenarios (representing High, Medium and Low greenhouse gas emissions).

Uncertainty in climate change projections can be a problem for those planning to adapt to a changing climate. Uncertainty within the projections of future climate change arises from the following causes:

- Natural climate variability
- Incomplete understanding of Earth system processes and their imperfect representation in climate models (known as modelling uncertainty)
- Uncertainty in future man-made emissions of greenhouse gases and other pollutants

However, UKCP09 takes account of these uncertainties by giving the projections in a range of probabilistic outputs. This means that the data shows a range of possible outcomes, and the probability of each outcome, based on how much evidence there is for different levels of future climate change. The change in the climate variable can be said to be 'very unlikely to be less than' at the 10% probability level and 'very unlikely to be more than' at the 90% probability level. The 50% probability level is known as the 'central estimate'. For further explanation of probability levels, see the UKCP09 website.

Future seasonal climate

The table and maps over the following few pages show a likely future where summers become increasingly hotter and drier, and winters become warmer and wetter. Whilst these changes may be gradual, in time they will significantly change what we consider to be 'normal' weather or climate. For instance, the high temperatures experienced during the 2003 heatwave, which is estimated to have caused 2000 excess heat-related deaths in the UK, were 2.3°C above average – this is likely to be considered a normal summer by the mid 21st Century and a cool summer by the 2080s.

It is also important to note that, in addition to the trends in average climate depicted in these maps and figures, the South West can expect more frequent weather extremes, such as heavy rainfall and heatwaves. Droughts like that experienced in 1976, which required standpipes to be used in Devon and cost UK agriculture £500 million in failed crops[8], could also become more frequent.

Evening light, North Cornwall © Rachel Malone www.oursouthwest.com

[8] 'The 1976 drought' (BBC Weather website 2010)

Future seasonal climate

Figures in the table below show likely changes in future climate for the South West. **The 'central estimate' (i.e. the value at the 50% probability level) under the medium emissions scenario is reported first, followed by the wider range of uncertainty in brackets.** The bracketed wider range uses the minimum value at the 10% probability level, and the maximum value at the 90% probability level, across all three emissions scenarios (IPCC SRES: B1, A1B, A1FI).

Season	2020s	2050s	2080s
Spring			
Mean temperature	Warmer by 1.2°C *(0.63 to 1.9°C)*	Warmer by 2.1°C *(1.0 to 3.6°C)*	Warmer by 2.9°C *(1.4 to 5.5°C)*
Precipitation	Marginally wetter by 0.1% *(-7.3 to +8.7%)*	Marginally drier by -0.5% *(-7.5% to +8.4%)*	Wetter by 1.7% *(-7.1 to +9.7%)*
Cloud cover	Decrease of -2.7% *(-6.7 to +2.2%)*	Decrease of -3.9% *(-8.7 to +0.5%)*	Decrease of -4.6% *(-11.3 to +1.8%)*
Relative humidity	Decrease of -1.2% *(-3.8 to +0.9%)*	Decrease of -2.0% *(-6.2 to +1.0%)*	Decrease of -2.5% *(-8.6 to +1.9%)*
Summer			
Mean temperature	Warmer by 1.6°C *(0.5 to 2.7°C)*	Warmer by 2.7°C *(1.1 to 5.1°C)*	Warmer by 3.9°C *(1.3 to 7.9°C)*
Precipitation	Drier by 8% *(-26.6 to +17.5%)*	Drier by 20% *(-44.5 to 16.1%)*	Drier by 24% *(-58.5 to 12.9%)*
Cloud cover	Decrease of -5.7% *(-14.2 to +4.5%)*	Decrease of -10.6% *(-22.9 to +2.0%)*	Decrease of -14.9% *(-33.9 to +1.3%)*
Relative humidity	Decrease of -3.1% *(-8.2 to +2.6%)*	Decrease of -5.5% *(-13.7 to +1.7%)*	Decrease of -7.3% *(-19.5 to +1.9%)*
Autumn			
Mean temperature	Warmer by 1.5°C *(0.77 to 2.5°C)*	Warmer by 2.7°C *(1.4 to 4.1°C)*	Warmer by 3.7°C *(1.7 to 6.5°C)*
Precipitation	Wetter by 1.5% *(-12.1 to +16%)*	Wetter by 3.2% *(-8.2 to +14.9%)*	Wetter by 4.0% *(-7.1 to +15.6%)*
Cloud cover	Decrease of -2.0% *(-6.3 to +1.8%)*	Decrease of -4.1% *(-9.3 to +0.4%)*	Decrease of -5.3% *(-5.6 to +0.4%)*
Relative humidity	Negligible decrease of -0.5% *(-2.3 to +1%)*	Decrease of -1.3% *(-3.7 to +0.7%)*	Decrease of -1.9% *(-5.6 to +0.4%)*

Continued

Future seasonal climate

Season	2020s	2050s	2080s
Winter			
Mean temperature	Warmer by 1.3°C *(0.46 to 2.0°C)*	Warmer by 2.1°C *(0.8 to 3.5°C)*	Warmer by 2.8°C *(1.4 to 5.1°C)*
Precipitation	Wetter by 7% *(-3.1 to +19.6%)*	Wetter by 17% *(0.0 to +40.6%)*	Wetter by 23% *(5.2 to 73.5%)*
Cloud cover	No change *(-2.2 to +2.1%)*	Negligible increase of 0.4% *(-2.0 to +2.8%)*	Negligible increase of 0.9% *(-1.9 to +3.9%)*
Relative humidity	Negligible decrease of -0.1% *(-0.6 to +0.5%)*	Negligible decrease of -0.1% *(-0.8 to +0.6%)*	No change *(-0.9 to +0.8%)*
Annual			
Mean temperature	Warmer by 1.4°C *(0.74 to 2.1°C)*	Warmer by 2.5°C *(1.3 to 4.0°C)*	Warmer by 3.5°C *(1.6 to 6.3°C)*
Precipitation	No change *(-4.8% to 6.0%)*	No change *(-6.0% to +6.4%)*	Wetter by 1% *(-7.2 to +9.6%)*
Cloud cover	Decrease of -2.7% *(-6.0 to +0.9%)*	Decrease of -5.2% *(-10.4 to -0.1%)*	Decrease of -6.6% *(-15.8 to -0.5%)*
Relative humidity	Decrease of -1.2% *(-2.9 to +0.4%)*	Decrease of -2.4% *(-5.6 to +0.03%)*	Decrease of -3.1% *(-8.3 to +0.1%)*

The maps over the next pages show changes in the South West's winter and summer temperatures and precipitation for the 2020s, the 2050s and the 2080s relative to the 'baseline' period of 1961-90. They were modelled using scenarios for high and low emissions of greenhouse gases.

Our climate

Our climate has always been in a state of change but what is significant now is the rate of change and the reasons for it.

Temperature

The world's leading scientists – the Intergovernmental Panel on Climate Change (IPCC) – warn that global temperatures could rise by between 1.1°C and 6.4°C by the end of this century[9]

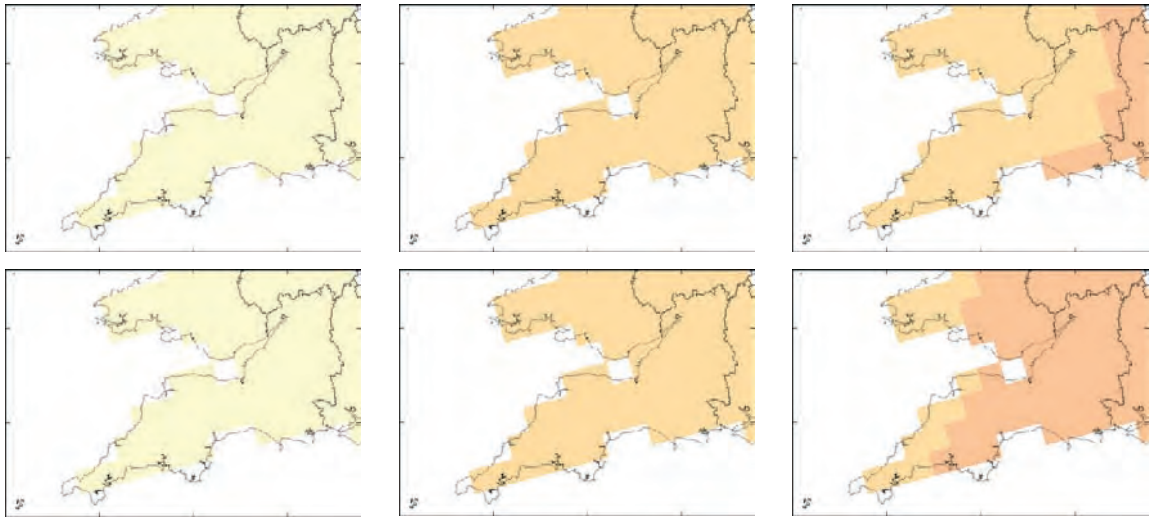
[9]IPCC Fourth Assessment Report: Climate Change 2007 (Synthesis Report)

Mean Temperature Change 2020s Winter

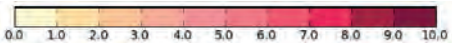
10% Very unlikely to be cooler than | **50%** Central estimate | **90%** Very unlikely to be warmer than

Low emissions scenario

High emissions scenario



Change in mean temperature (deg C)



Mean winter temperature by the 2020s is very unlikely to increase by less than 0.5°C, and very unlikely to increase by more than 2°C. The central estimate is an increase of 1.2°C.

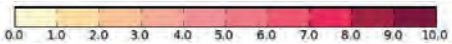
Mean Temperature Change 2020s Summer

10% Very unlikely to be cooler than | **50%** Central estimate | **90%** Very unlikely to be warmer than

Low emissions scenario

High emissions scenario

Change in mean temperature (deg C)



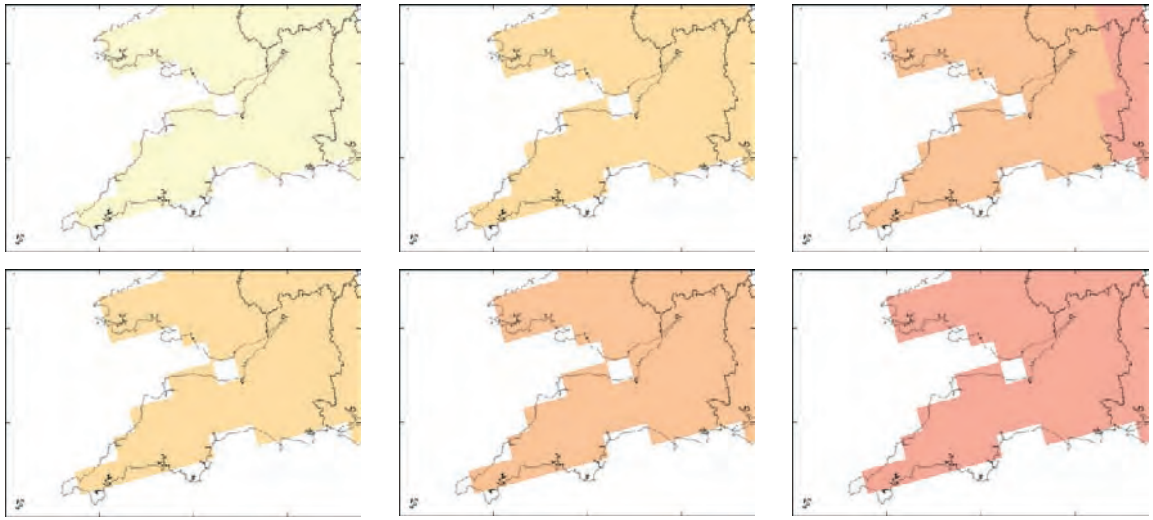
Mean summer temperature by the 2020s is very unlikely to increase by less than 0.7°C, and very unlikely to increase by more than 2.7°C.
The central estimate is an increase of 1.5 – 1.6°C, depending on the emissions scenario.

Mean Temperature Change 2050s Winter

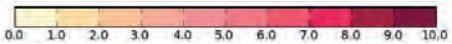
10% Very unlikely to be cooler than | **50%** Central estimate | **90%** Very unlikely to be warmer than

Low emissions scenario

High emissions scenario



Change in mean temperature (deg C)



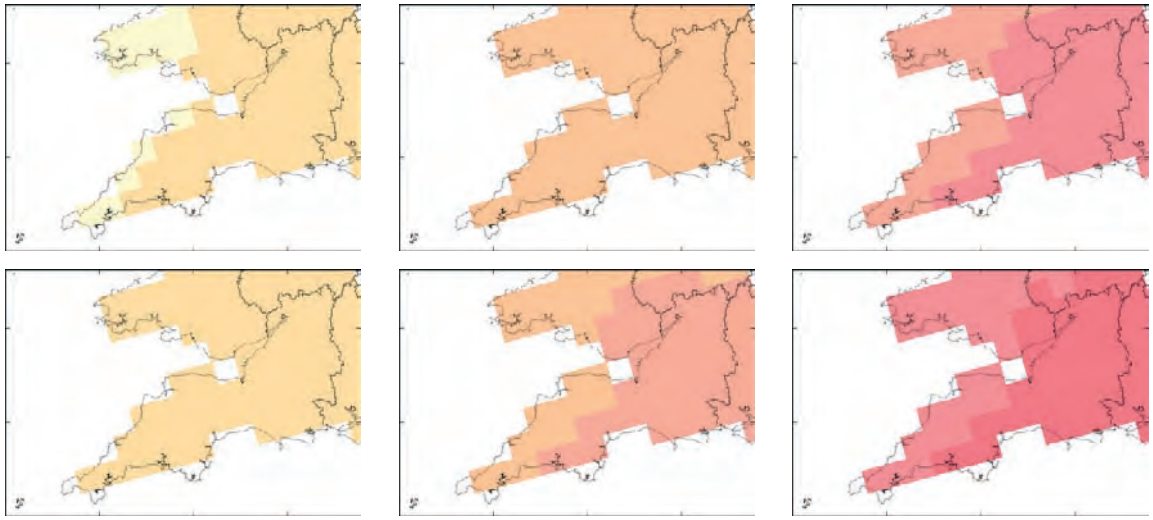
Mean winter temperature by the 2050s is very unlikely to increase by less than 0.8°C, and very unlikely to increase by more than 3.5°C.
The central estimate is an increase of 1.8 – 2.3°C, depending on the emissions scenario.

Mean Temperature Change 2050s Summer

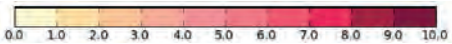
10% Very unlikely to be cooler than | **50%** Central estimate | **90%** Very unlikely to be warmer than

Low emissions scenario

High emissions scenario



Change in mean temperature (deg C)



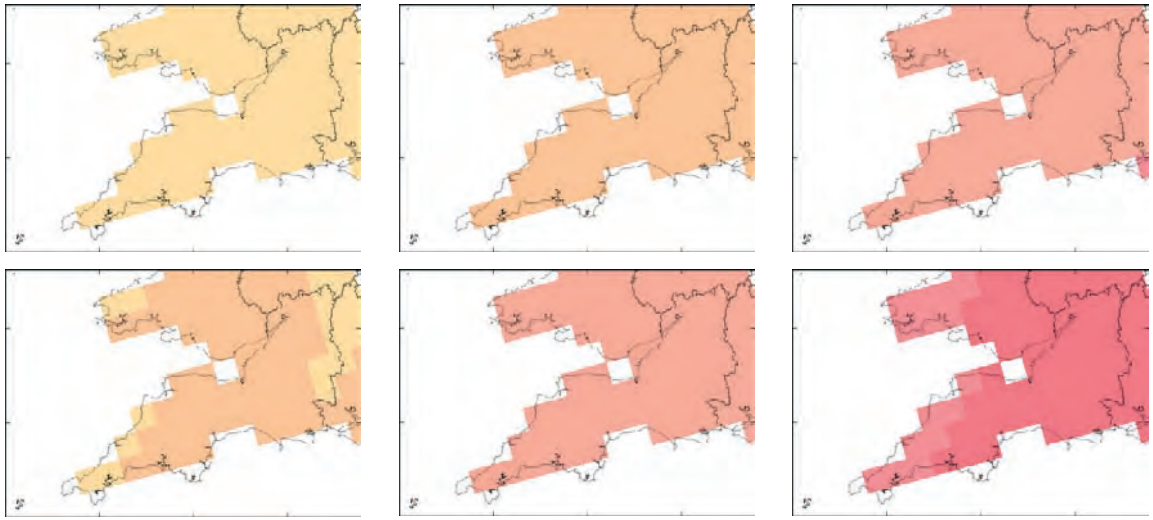
Mean summer temperature by the 2050s is very unlikely to increase by less than 1.1°C, and very unlikely to increase by more than 5.1°C.
The central estimate is 2.5 – 3.1°C, depending on the emissions scenario.

Mean Temperature Change 2080s Winter

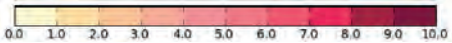
10% Very unlikely to be cooler than | **50%** Central estimate | **90%** Very unlikely to be warmer than

Low emissions scenario

High emissions scenario



Change in mean temperature (deg C)



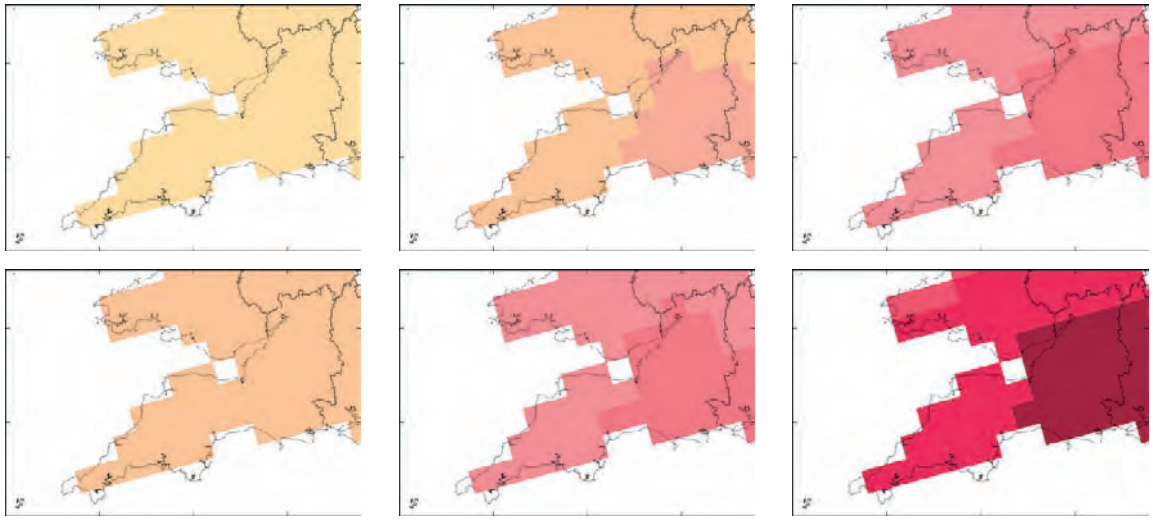
Mean winter temperature by the 2080s is very unlikely to increase by less than 1.4°C and very unlikely to be increase by more than 5.1°C.
The central estimate is an increase of 2.4 – 3.4°C, depending on the emissions scenario.

Mean Temperature Change 2080s Summer

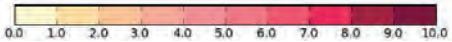
10% Very unlikely to be cooler than | **50%** Central estimate | **90%** Very unlikely to be warmer than

Low emissions scenario

High emissions scenario



Change in mean temperature (deg C)



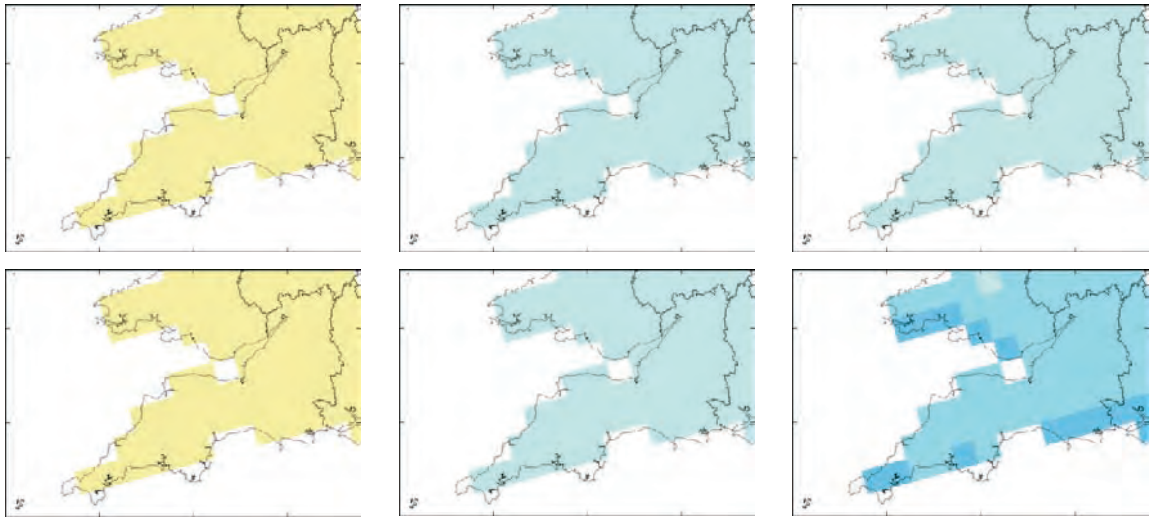
Mean summer temperature by the 2080s is very unlikely to increase by less than 1.3°C and very unlikely to increase by more than 7.9°C.
The central estimate is an increase of 2.9 – 5°C, depending on the emissions scenario.

Precipitation Change 2020s Winter

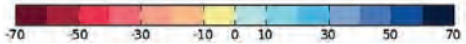
10% Very unlikely to be drier than | **50%** Central estimate | **90%** Very unlikely to be wetter than

Low emissions scenario

High emissions scenario



Change in precipitation (%)



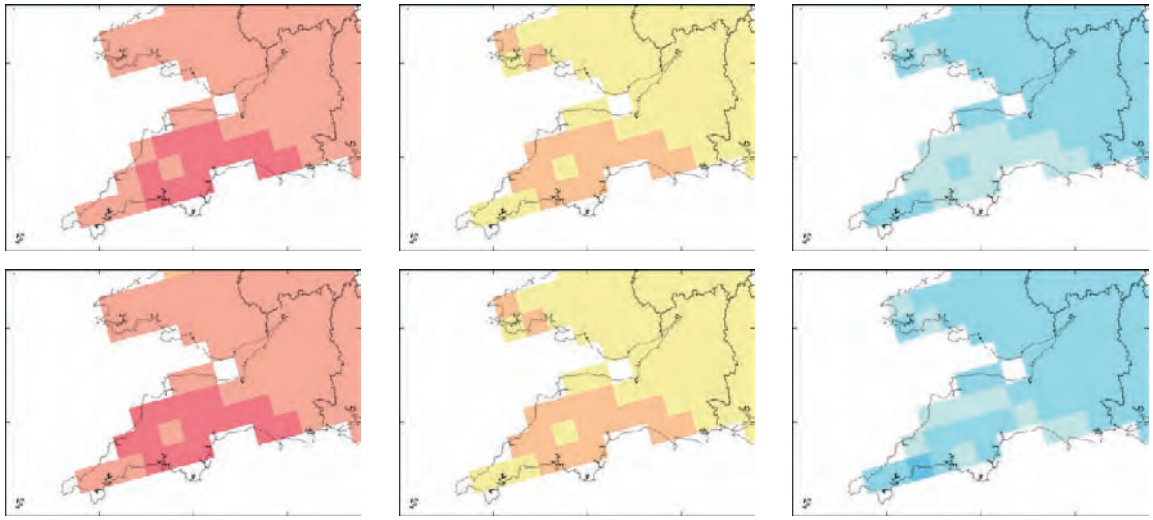
Mean winter precipitation by the 2020s is very unlikely to decrease by more than 3.1 % and very unlikely to increase by more than 19.6 %. The central estimate is an increase of 6 %.

Precipitation Change 2020s Summer

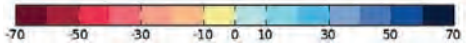
10% Very unlikely to be drier than | **50%** Central estimate | **90%** Very unlikely to be wetter than

Low emissions scenario

High emissions scenario



Change in precipitation (%)



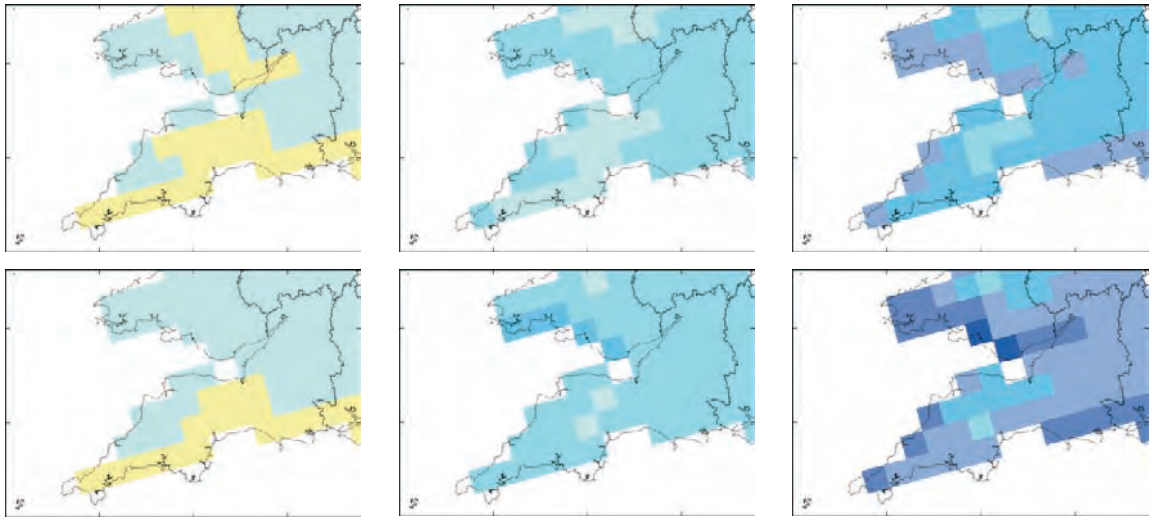
Mean summer precipitation by the 2020s is very unlikely to decrease by more than 26.6 % and very unlikely to increase by more than 17.5 %.
The central estimate is a decrease of 5 – 7 %, depending on the emissions scenario.

Precipitation Change 2050s Winter

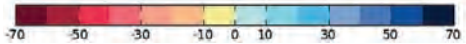
10% Very unlikely to be drier than | **50%** Central estimate | **90%** Very unlikely to be wetter than

Low emissions scenario

High emissions scenario



Change in precipitation (%)



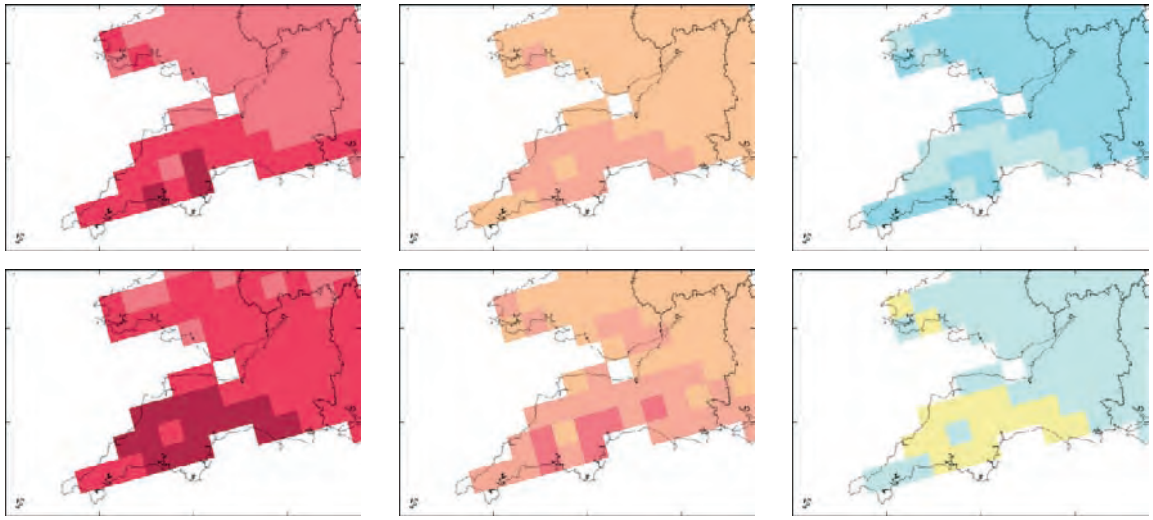
Mean winter precipitation by the 2050s is very unlikely to decrease and very unlikely to increase by more than 40.6 %. The central estimate is an increase of 12 – 18 %, depending on the emissions scenario.

Precipitation Change 2050s Summer

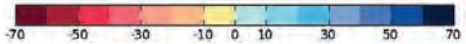
10% Very unlikely to be drier than | **50%** Central estimate | **90%** Very unlikely to be wetter than

Low emissions scenario

High emissions scenario



Change in precipitation (%)



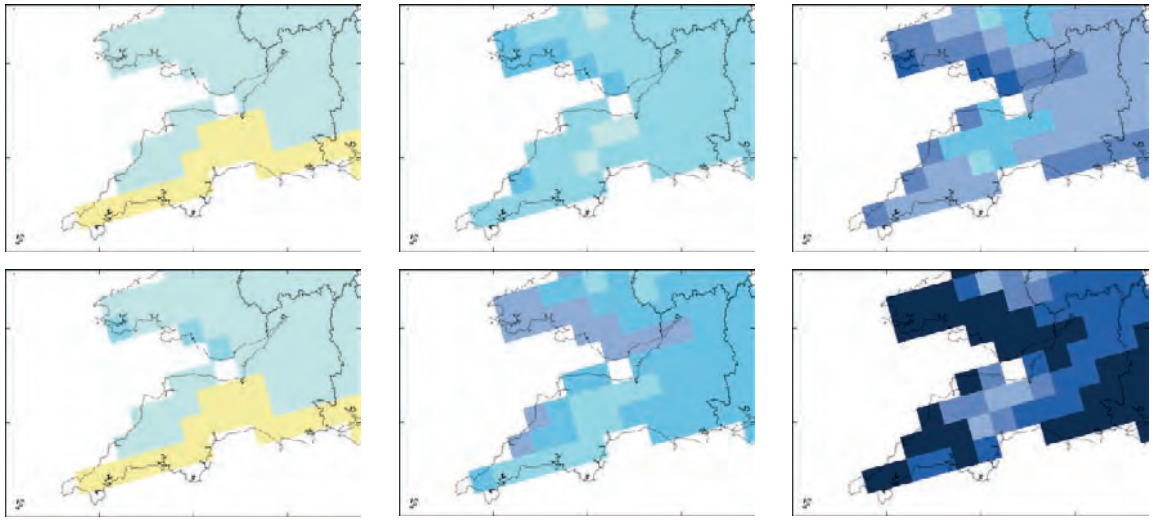
Mean summer precipitation by the 2050s is very unlikely to decrease by more than 44.5 % and very unlikely to increase by more than 16.1 %.
The central estimate is a decrease of 14 – 20 %, depending on the emissions scenario.

Precipitation Change 2080s Winter

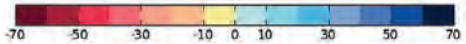
10% Very unlikely to be drier than | **50%** Central estimate | **90%** Very unlikely to be wetter than

Low emissions scenario

High emissions scenario



Change in precipitation (%)



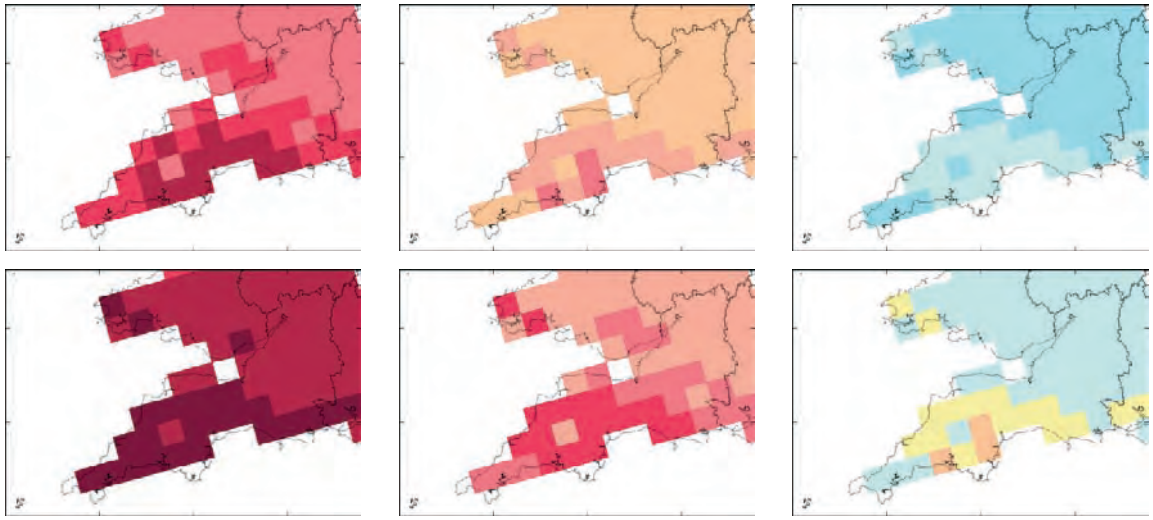
Mean winter precipitation by the 2080s is very unlikely to increase by less than 5.2% and very unlikely to increase by more than 73.5%. The central estimate is an increase of 19 – 31%, depending on the emissions scenario.

Precipitation Change 2080s Summer

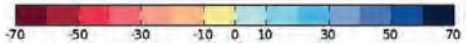
10% Very unlikely to be drier than | **50%** Central estimate | **90%** Very unlikely to be wetter than

Low emissions scenario

High emissions scenario



Change in precipitation (%)



Mean summer precipitation by the 2080s is very unlikely to decrease by more than 58.5% and very unlikely to increase by more than 12.9%.
The central estimate is a decrease of 16 – 30%, depending on the emissions scenario.

Future seasonal climate

Changes in the marine environment

Projected changes in the marine and coastal environment are also available as part of the UK Climate Projections (2009). Model projections are available for change in sea level, skew surge (an element of storm surge - see UKCP09 Index for a full explanation), and multi-level ocean variables (e.g. sea surface temperature, salinity)[10].

For the South West as a whole, small increases in storm surge are projected everywhere, with the largest increases being for locations in the Bristol Channel and Severn Estuary.

Projected Change in Relative Sea Level

Projections of change in relative sea-level (which accounts for vertical land movement) are available under three different emissions scenarios, and are not probabilistic. For the South West, all grid cells are projected to witness an increase in relative sea level. The table on the following page provides a summary of changes for three sites in the South West.

These rises in sea level will increase the risk of coastal flooding and erosion, with implications for businesses, householders, and the maintenance of amenities (such as footpaths) along vulnerable stretches of coastline.

[10]UKCP09 Marine and Coastal Projections report (Lowe et al. 2009. Met Office Hadley Centre)

Future seasonal climate

Changes in relative sea level in the South West

Projected changes in relative sea level with respect to 1990, in cm. Values are given throughout the 21st Century, for three sites in the South West . The name of the site and grid cell ID is given in the table. Values are given for all three emissions scenarios (low, medium, and high), at three percentile levels: the 50th percentile value is given first, with the 5th and 95th percentile values in brackets.

	Bournemouth (25541)			Newlyn (26933)			Weston-super-Mare (23888)		
Year	Low	Medium	High	Low	Medium	High	Low	Medium	High
2020	8.4 (4.7 - 12.1)	9.9 (5.0 - 14.7)	11.6 (5.5 - 17.8)	9.6 (5.9 - 13.3)	11.0 (6.2 - 15.9)	12.8 (6.6 - 19.0)	8.3 (4.6 - 12.0)	9.8 (4.9 - 14.6)	11.5 (5.3 - 17.7)
2030	11.6 (6.4 - 16.9)	13.7 (6.8 - 20.5)	16.2 (7.5 - 24.9)	13.2 (8.0 - 18.4)	15.3 (8.4 - 22.1)	17.7 (9.1 - 26.4)	11.5 (6.3 - 16.7)	13.5 (6.7 - 20.4)	16.0 (7.4 - 24.7)
2040	15.1 (8.2 - 22.0)	17.8 (8.8 - 26.8)	21.1 (9.6 - 32.5)	17.1 (10.2 - 23.9)	19.7 (10.7 - 28.7)	23.0 (11.6 - 34.4)	14.9 (8.1 - 21.8)	17.6 (8.6 - 26.6)	20.9 (9.5 - 32.3)
2050	18.8 (10.1 - 27.4)	22.1 (10.8 - 33.4)	26.2 (11.9 - 40.6)	21.1 (12.5 - 29.7)	24.5 (13.2 - 35.8)	28.6 (14.3 - 42.9)	18.5 (9.9 - 27.2)	21.9 (10.6 - 33.2)	26.0 (11.7 - 40.4)
2060	22.6 (12.1 - 33.2)	26.7 (13.0 - 40.5)	31.8 (14.3 - 49.3)	25.4 (14.9 - 35.9)	29.5 (15.7 - 43.3)	34.5 (17.0 - 52.0)	22.4 (11.9 - 32.9)	26.5 (12.7 - 40.3)	31.5 (14.0 - 49.0)
2070	26.7 (14.2 - 39.3)	31.6 (15.2 - 48.1)	37.6 (16.8 - 58.5)	29.9 (17.3 - 42.4)	34.8 (18.3 - 51.2)	40.8 (19.9 - 61.6)	26.5 (13.9 - 39.0)	31.3 (14.9 - 47.8)	37.3 (16.5 - 58.2)
2080	31.0 (16.3 - 45.8)	36.8 (17.5 - 56.0)	43.8 (19.4 - 68.3)	34.6 (19.9 - 49.3)	40.3 (21.0 - 59.6)	47.3 (22.9 - 71.8)	30.7 (16.0 - 45.4)	36.5 (17.2 - 55.7)	43.5 (19.0 - 67.9)
2090	35.6 (18.6 - 52.6)	42.2 (19.9 - 64.4)	50.3 (22.1 - 78.6)	39.5 (22.5 - 56.5)	46.1 (23.9 - 68.4)	54.2 (26.0 - 82.5)	35.2 (18.2 - 52.2)	41.8 (19.6 -64.1)	50.0 (21.7 - 78.2)
2095	37.9 (19.7 - 56.1)	45.0 (21.2 - 68.8)	53.7 (23.5 - 83.9)	42.0 (23.8 - 60.2)	49.1 (25.3 - 72.9)	57.8 (27.6 - 88.0)	37.5 (19.3 - 55.7)	44.6 (20.8 - 68.4)	53.3 (23.1 - 83.6)

Graphs showing the projected changes in relative sea level rise and storm skew surge for selected sites in the South West are available on request from Climate SouthWest. The complete set of projections can be freely obtained from the UKCP09 User Interface.

Our natural environment

One of the South West's greatest assets is its natural environment. It helps attract tourists and supports over 12% of the South West's businesses, in agriculture and related sectors[11].

Over a third of the South West comprises national parks or areas of outstanding natural beauty and much of the coastline, which includes 60% of the UK's Heritage Coast[12], is spectacular. The high quality environment attracts people to the South West and helps drive economic development and regeneration.

The natural environment is susceptible to climate change and needs to be enhanced if we are to protect human life. For example, the peatlands of Bodmin, Dartmoor & Exmoor support internationally important mires and heaths, provide 70% of our local drinking water and lock up huge amounts of carbon[13]. The increasing chance of summer drought jeopardises all of this but efforts to restore the water balance of these peatlands, for example, by blocking man-made drains, will make them more resilient.

Sectors related to the natural environment, such as water companies and nature conservation organisations, have been identified as among the best informed in terms of climate change and its impacts.

Autumn sunrise at the Cotswold Water Park © Phil Harding www.oursouthwest.com

[11]Response from the South West of England region to the European Commission's Green Paper: Towards a future Maritime Policy for the Union (South West Maritime Task and Finish Group 2007)
[12]The South West: Key facts (Government Office South West 2010)
[13]Mapping values: the vital nature of our uplands (Natural England 2009)

Our natural environment

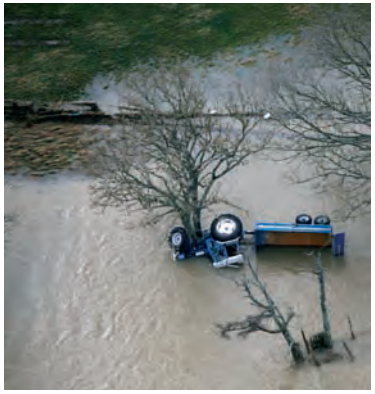
Agriculture and horticulture

Agriculture accounts for 70% of the South West's land-use by area (1.2m hectares in 2009[14]) and the sector employs 3.1% of the regional workforce[15]. Agriculture and associated activities play a major role in maintaining the South West's distinctive and varied landscape.

"Uncertainty" is one of the biggest risks for this sector, as businesses are reluctant to act until they have some certainty on weather patterns and new markets. However, even with this uncertainty there are opportunities that farmers can be (and are) taking up. For instance, good soil management makes good business sense, as it helps to reduce the costs of soil erosion and contributes to a more efficient enterprise.

Key impacts

- Higher carbon dioxide levels and a longer growing season will enhance the growth of some crops and offer the potential for growing new crops such as sunflower, sweetcorn, grapes and bio-fuels including vegetable oils.
- Potential increase in pests and diseases, including species new to the region.
- Increased need for irrigation, owing to reduced summer rainfall and higher temperatures.



'Look at the sustainable opportunities rather than just the limitations and restrictions implied by climate change'

Mark Diacono, Devon farmer

[14]Agriculture in the English Regions 2009 (Defra and National Statistics)
[15]South West Regional Accounts 2010

Our natural environment

Biodiversity, habitat, conservation & landscapes

Almost 40% of the South West is designated for its high quality landscape and 10% for internationally or nationally important wildlife sites. The South West has the largest area of semi-natural habitat of any English region and a particular responsibility to enhance chalk & limestone grasslands, lowland meadows, salty lagoons (the Fleet in Dorset is England's largest), shallow marine reefs and lowland heaths[16].

Many habitats occur as small islands surrounded by farmland. Small populations of native plants and animals can be extinguished by extreme weather events and, unless the interleaving land can be made more hospitable, they will be unable to move quickly enough to track the changing climate. For example, the beautiful marsh fritillary butterfly only travels 500 metres in any one year, so their existing habitat (marshy grassland) needs to be increased in area and adjacent patches need to be within their range[17].

Mudflats on the River Tavy – mudflats are important inter-tidal habitats but are at risk from rising sea levels

Key impacts

- Greater erosion of peaty soils if drier summers are followed by more intense autumn rainstorms.
- Greater incidence of algal blooms & fish death as water temperatures rise and flows decline in summer.
- A shift in the distribution of species. In the last 25 years, species have moved up to 60km north and an average of 25m 'up hill'[18]. The South West has already gained little egrets, greater horseshoe bats and red-eyed damselflies but stands to lose golden plovers, ring ouzels and greater mouse-eared bats.

There is increasing evidence for changes in the timing of many natural events which are closely correlated with changing temperatures. These changes may mean that the life cycles of some species are no longer synchronised with those of species on which they depend (e.g. food plants and prey species). This is particularly acute in long-distance migrants, such as the pied flycatcher, where the peak in their caterpillar food is earlier but the arrival of the birds in spring is unchanged.

'There has been an advance in the leafing date of oak by about 3 weeks since the 1950s, with leafing now consistently earlier than prior to 1990.'

Forestry Commission[19]

'The South West's economy can thrive in the future if we take proactive care of our coastal assets.'

Tony Flux, National Trust

[16]State of the natural environment in the South West (Natural England 2009)
[17]Metapopulation structure and movements in five species of checkerspot butterflies (Wahlberg et.al. 2002)
[18]Biodiversity and climate change – a summary of impacts in the UK (Inter-agency Climate Change Forum 2010)
[19]Combating climate change: a role for UK forests (Forestry Commission 2009)

Our natural environment

Coastal areas

The South West's long coastline is fundamental to its economy and its inhabitants' quality of life. It helps draw in over 21 million tourists a year and attracts inward migration and investment. With almost half the UK's designated bathing waters[20], the South West has nearly half of the UK's top beaches, as listed by the Marine Conservation Society's Good Beach Guide and more than 1000km of coastline[21].

The national and international significance of the South West's coastline is shown by the many environmental designations including; Lundy Island, England's only marine nature reserve; and Dorset and East Devon's Jurassic Coast, the only natural UNESCO World Heritage Site in mainland UK. Several sites in the South West are also due to be designated as Marine Conservation Zones under the Marine and Coastal Access Act 2009 (final sites are will be decided by June 2011).

Key impacts

- Rising sea levels, unpredictable coastal dynamics and possible increased wave heights will increase coastal erosion and damage coastal amenities.
- Natural assets such as beaches, wetlands, mudflats, salt marshes and dunes may be lost and their flora and fauna will be affected.
- Over half of the best agricultural land in the UK is situated less than 5 metres above sea level[22] and may, therefore, be at risk of inundation.
- Protecting or relocating coastal assets may be too costly and in some cases managed retreat may be the best option.

[20]Portrait of the South West (E. Smith, Office for National Statistics 2010)
[21]Response from the South West of England region to the European Commission's Green Paper: Towards a future Maritime Policy for the Union (South West Maritime Task and Finish Group 2007)
[22]Lands at risk from sea-level rise in the UK (Whittle, I.R. in 'Greenhouse Effect and Rising Sea Level in the UK' Doornkamp, J.C (Ed) 1990).

Our natural environment

Forestry

The South West's landscape includes historic woodland in areas such as the Forest of Dean and parts of Exmoor, newer conifer plantations and large areas owned by the National Trust and Woodland Trust.

Climate change will affect the health of trees and how they are managed. However, the forestry industry is familiar with the risk of extreme weather and is generally very well informed on the possible effects of climate change.

Trees and woodlands are important, as they help to reduce climate change by absorbing carbon dioxide and can also help us adapt to the impacts - for instance by offering shade, alleviating flooding and providing valuable wildlife habitat.

Westonbirt in October © Rachel Malone, 2008, www.oursouthwest.com

Key impacts

- New plantations could be affected by soil moisture deficits in summer and drought can put trees under stress, reducing the quality of the timber they supply.
- There may be greater susceptibility to fungal diseases, such as *Phytophthora ramorum*, more damage by green spruce aphid, and the prospect of new or imported diseases taking hold.
- Floodplain forestry (e.g. short rotation coppice such as willow) may be a suitable adaptation for frequently flooded agricultural land.
- Higher carbon dioxide concentrations in the atmosphere could increase growth rates and productivity and increase the growing season for some species.

A tree infected with *Phytophthora Ramorum* © Joseph O'Brien, USDA Forest Service, Bugwood.org

Our natural environment

Sea fisheries

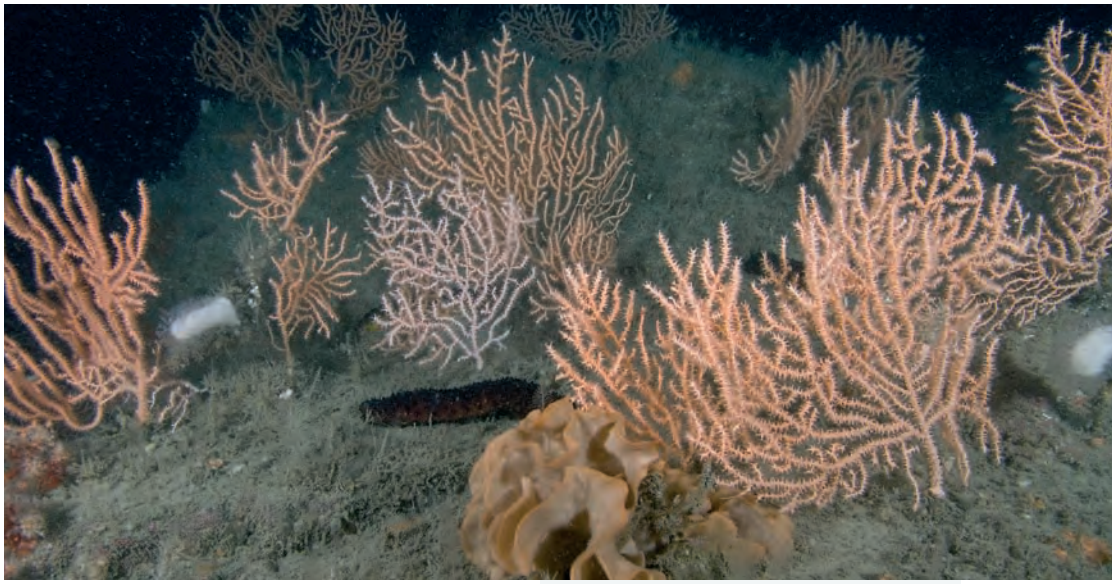
Sea fisheries are an important part of the South West's economy and 42% of England's fishing operations are in the region[23].

Coastal waters of the South West mark a boundary between warm southern and cool northern seas, which creates an abundance of species. There is evidence that fish species are changing in South West waters, with stocks of warm water species such as sea bass growing considerably in recent years[24].

The Marine Climate Change Impacts Partnership (MCCIP) is an extensive source of information on climate change in the marine environment and is working to promote adaptation. The Partnership 'synthesises broad based evidence on how climate change is affecting our coast and seas and its impacts on; marine ecosystems; cleanliness and safety; and commercial activities'.

Key impacts

- Rising global temperatures are likely to reduce the oceans' overall productivity, affecting species across the entire marine food chain.
- Higher levels of carbon dioxide are making the oceans more acidic, threatening marine ecosystems and reducing the ability of some organisms to make shells and skeletons (calcification). Acidity has already increased by 30% over the last 200 years[25].
- Fish are particularly sensitive to small changes in temperature, causing changes in distribution at the extremities of their ranges. This may provide significant challenges to this South West fishing industry.
- With the North Atlantic warming, there will be significant losses of indigenous species to the north. Research has shown that cod populations fall as the seas warm up.



Sea fans and soft corals near Plymouth © Paul Naylor

Juvenile cod © Paul Naylor

[23]Response from the South West of England region to the European Commission's Green Paper: Towards a future Maritime Policy for the Union (South West Maritime Task and Finish Group 2007)
[24]2010-11 Annual MCCIP Report Card (Marine Climate Change Impacts Partnership 2010)
[25]2010-11 Annual MCCIP Report Card (Marine Climate Change Impacts Partnership 2010)

'Climate change is extending the distribution of some fish, such as some species of sea bream. These now have the potential to become valued commercial species, holding their own with imported farmed fish'

Doug Herdson, Marine Fish Information Services

Our natural environment

River flooding and drainage

Rivers vary widely across the South West, from the chalk streams of Salisbury Plain via the sluggish, flood-prone rivers of the Somerset Levels and Moors to the fast-flowing Cornish rivers. Climate change increases the risk of river and urban flooding and extreme events, such as the 2007 Gloucestershire floods and the 2003 flash flooding in Boscastle, are likely to become more frequent (although note that individual events cannot be directly attributed to climate change).

Following the 2007 summer floods, the Government called for an independent review of flood risk management. The 'Pitt Review[26]' made 92 recommendations addressed to a range of bodies, including the Government, local authorities and insurers.

Many of these recommendations have been taken forward and are improving our ability to anticipate and respond to floods. For instance, a joint Met Office and Environment Agency 'Flood Forecasting Centre' has now been established, and the Flood and Water Management Bill introduced. However, although good progress has been made, climate change will continue to pose challenges to our flood risk management, requiring a continuous and dynamic response.

'Adaptation actions should be integrated into development policy and planning at every level. … ignoring climate change is not a viable option – inaction will be far more costly than adaptation'

Stern Review[27]

'Research suggests that, in the South West, a 2°C rise could increase annual insured flood losses by 19% - leading to a potential pricing increase to premiums of up to 16%'

Association of British Insurers[28]

[26]Learning Lessons from the 2007 Floods (Sir Michael Pitt, 2008)
[27]The Stern Review on the Economics of Climate Change (2008)
[28]The Financial Risks of Climate Change (Association of British Insurers, 2009)

Key impacts

- Increased flood risk in urban areas, requiring more use of sustainable urban drainage and other flood risk management measures in construction practices. New developments on floodplains will also need to be avoided, which may be a challenge given the ongoing need for extra housing.
- Increased flood risk to property in some areas. This may lead to increased insurance premiums, or difficulty in obtaining insurance cover in the future.
- More heavy rainfall will increase the risk of soil erosion and run-off from agricultural land, which could in turn increase local flood risk and harm water quality.
- Drainage systems will be put under increasing pressure by heavy rainfall, requiring design standards to be re-appraised for both new and engineering structures.

Our natural environment

Water resources and water quality

Over the coming century the South West's water resources will come under greater strain as summer droughts potentially become more intense and grow longer, and demand for irrigation grows. The results of an Environment Agency study suggest that river flows may halve in the summer months by the 2050s, with some areas seeing a possible decrease of up to 80 per cent[29].

Potential impacts of climate change have been considered in depth by water companies and the Environment Agency. These impacts will differ across the South West because of variations in geology, topography and surface drainage.

Key impacts

- Potential increases in demand for household, irrigation and industrial uses, as population rises, summer rainfall decreases and temperatures increase.
- Potential decreases in water supply as summer rainfall decreases and temperatures rise.
- Increased risk of flushing of nitrates and harmful organisms such as cryptosporidium into groundwater and watercourses in wetter winters with consequent human health impacts. More prolonged dry periods will also increase this risk, due to the organisms being washed into watercourses when the first flush of rainstorms arrive.
- Reduced water quality in summer as lower river flows will mean less dilution of pollutants.

[29]Climate Change and River Flows in the 2050s (Environment Agency 2008)

Our natural environment

Recommendations and actions

- Identify the most vulnerable soils and put them into long term management that enhances infiltration so as to prevent soil erosion and run-off. This will help to reduce the risk of surface water floods during storm events, as well as sequestering carbon, enhancing biodiversity and protecting our archaeological heritage.
- Public, private and third sector collaboration to restore habitat and extensive land management within 'Strategic Nature Areas'[30]. These areas are acknowledged as the most likely places to make populations of species more resilient, and accrue greater human benefits, in the face of climate change.
- Invest in enhancing the quality and amount of urban green space, which help us to cope with rising temperatures, flooding and drought, as well as improving the quality of the lives of the most disadvantaged people. Local authorities and other public bodies should work to:
  - understand the local situation by gathering evidence of vulnerability (data, records, knowledge, field observations);
  - validate the evidence through group discussions across the local, scientific, governmental and non-governmental community;
  - help people to tackle the root-cause of vulnerability so that solutions can be sustained;
  - and work within cultures and with social networks.
- Monitor changes in our rivers, estuaries and seas and manage the consequent impacts on habitats and biodiversity. Spatial boundaries of environmental designations may have to become more flexible to take into account the gradual changes in species distribution.
- Raise awareness of the increasing pressure on water supplies and encourage increased water efficiency in businesses and households.
- Continue to: raise awareness of coastal erosion and flood-risk; avoid developments being built on floodplains; and encourage at-risk businesses and households to implement food resistance and resilience measures.

[30]South West Nature Map

Our society and infrastructure

The South West's physical infrastructure – including its buildings, bridges, power lines, roads and railways – is vulnerable to most aspects of climate change. Long lead-times and investment periods mean that future or projected climate changes must be taken into account now by those responsible for infrastructure.

Changes in extreme conditions will have the greatest impact on infrastructure. The likelihood of extreme weather events will increase and it is these that will cause physical damage through flooding, storm damage and high temperatures.

Climate change will affect energy demand in the South West. Reduced heating demand in winter may be offset by increased demand for summer cooling. Opportunities for renewable energy such as wind and wave power, hydrogeneration and biomass are of particular importance to the region.

Our lifestyles could be influenced by climate change through choices of holiday destinations and timings, increased walking and cycling and more use of urban open spaces. This may mean increased exposure to the sun's radiation with associated cancer risks.

Clifton Suspension Bridge © Dawn Christopher www.oursouthwest.com

Our society and infrastructure

Built environment

Across the South West there are threats to the built environment, which is vulnerable to extreme weather - including flooding, high temperatures, droughts and storms. 70% of buildings that will be here in the 2050s have already been built[31], making it essential to retrofit existing buildings as well as integrate adaptation measures into new builds.

There are also opportunities to adapt the wider urban environment through increasing green infrastructure in the region. Green spaces in urban areas can help to reduce run-off (and therefore flood risk), provide shade, and reduce temperatures in the local environment.

Key impacts

- Increased need for cooling of buildings in summer but less demand for heating in warmer winters. Practical technologies are needed for passive cooling of buildings, to avoid more releases of greenhouse gases in powering cooling plants.
- Reduced summer rainfall and more frequent droughts will put pressure on water supplies. Increased use of existing water efficient and rainwater harvesting technologies is, therefore, needed to reduce water consumption in buildings, especially in summer.
- Wetter winters and heavier rainfall will exacerbate problems with damp and leaks in older buildings, as well as increase the risk of flooding.
- Increased solar radiation may provide more opportunity for solar heating in winter and cooling in summer.

Torfen building © White Design

Lynmouth
© Mark Christopher www.oursouthwest.com

[31]Powering our lives: Sustainable Energy Management and the Built Environment (Foresight 2008)

Our society and infrastructure

Housing

Many housing professionals are beginning to recognise that the impacts of climate change pose a number of challenges for the sector. New buildings will have to be designed to take account of factors such as increased clay soil shrinkage, the need for more ventilation and increased rain penetration. Developers will have to avoid floodplains as the severity and frequency of winter flooding increases.

Although awareness is growing, the housing sector has, in the past, not considered the impacts of climate change to the extent that is needed, as reducing carbon emissions to mitigate climate change tended to be higher on the agenda. Professionals need to place greater emphasis on adapting to extreme weather and climate change if our housing is to remain fit for purpose in the future.

Key impacts

- Housing will be at increased risk from flooding and will need to be resilient to heavy rainfall and storms.
- Housing will need to be able to cope with increased temperatures and become more water efficient to reduce pressure on increasingly scarce water supplies.
- Buildings on clay are vulnerable to subsidence and ground movement from clay drying and shrinking during drought.
- The changing climate is likely to have an effect on residents' behaviour and expectations – for example, the demand for outdoor space may grow. The design of buildings and housing developments will need to take this into account if the quality of life for residents is to be sustained and improved.

In the 2007 Gloucestershire floods, nearly 6000 properties were flooded, 10,000 people were trapped on the M5 and railways, 42,000 were without power for 42 hours and 350,000 were without water for up to 17 days[26].

85% of businesses are aware that climate change is a problem for the world but only 26% think it is a real threat to them

AXAInsurance[32]

[32]Climate change and its effects on small businesses in the UK (AXA Insurance, 2006)

Our society and infrastructure

Health

Climate change is already impacting on our health and could exacerbate incidences of skin cancer and respiratory disease. Higher temperatures may reduce air quality, damaging health, and new or foreign diseases may start to be found in this country.

While primary effects such as this are well recognised, attention also needs to be focused on the related social effects, including health inequalities and the impact of extreme events on mental health. On the positive side, increased opportunities for outdoor activities may improve public health and obesity levels, and milder winters will reduce the number of cold-related deaths.

Key impacts

- Warmer, sunnier summer weather is likely to encourage more outdoor leisure and lighter clothing, increasing exposure to the sun and related risks, such as skin cancer and heatstroke.
- Climate change will increase the frequency of heatwaves, which affect the health and safety of workers as well as causing short-term increases in mortality and ill health, particularly in the sick and elderly.
- Milder winters would reduce winter cold-related mortality rates.
- Climate change is likely to increase flood risk, with long-term psychological impacts for those affected.

'The 2003 heatwave attracted record numbers of visitors to Bournemouth and Poole. Traffic numbers were 20% higher than normal and "Bournemouth, traditionally renowned for its bracing sea air, was among five Government monitoring sites where pollution was double the health standard.'

Dorset Echo, August 2003

Our society and infrastructure

Heritage

The South West is one of the UK's richest areas of natural and cultural heritage. It has nearly a quarter of all England's listed buildings and over a third of the scheduled ancient monuments[33]. Heritage is particularly important for South West tourism, attracting visitors to the area as a whole, as well as to specific sites.

Stonehenge © Elizabeth Cooksey www.oursouthwest.com

Key impacts

- Increased visitor pressures and increased revenue for historic buildings from expansion in tourism in a warmer climate.
- Potential increase in storm damage, light-degradation, rain damage, fungal and beetle damage to historic buildings.
- Maintenance of historical planting schemes will be difficult in gardens which were created in a colder climate. There are opportunities to grow new exotic plant species, although the arrival or expansion of invasive non-native species may be a problem.
- Archaeology conserved in peat uplands could deteriorate, as the soils dry out in summer and sites in coastal locations may be lost as sea levels rise.

Corfe Castle, Dorset © Matt Redmond www.oursouthwest.com

[33]English Heritage 2010

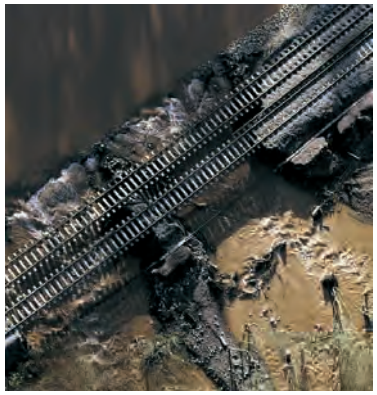
Our society and infrastructure

Transport

Traditionally, transport professionals have tended to pay greater heed to short-term weather problems, such as wind-blown leaves on rail track or snowdrifts, rather than planning for the likely implications of climate change. However, some national transport providers are starting to assess the impacts of climate change and the need to adapt; recognising that an increase in the frequency of extreme events will increase the risk of disruption. Many roads and rail tracks are already vulnerable to flooding, high temperatures can cause tarmac to melt and rail tracks to buckle, and certain coastal routes (e.g. the railway at Dawlish and the coast road at Slapton) are at risk from coastal erosion and sea level rise.

Key impacts

- Some towns, cities and transport routes are susceptible to periodic flooding, causing major disruption to road transport.
- Railways along the coast are vulnerable to storm surges, high tides and cliff instability while tunnels are vulnerable to flooding.
- High temperatures could cause rail tracks to buckle, roads to melt, and public transport to become uncomfortably hot for drivers and passengers.
- Pressure on the capacity and management of transport infrastructure could increase if warmer summers attract more visitors to the South West.



Our society and infrastructure

Recommendations and actions

- Transport and utilities infrastructure companies should undertake risk assessments to identify vulnerable locations and the likely consequences of extreme weather, and develop appropriate adaptation responses, such as the creation of diversionary routes.
- Relevant bodies should review opportunities for increased production of renewable energy – wind, water turbine, solar, biomass, wave, tide, and biofuels.
- Those responsible for developing and managing housing stock need to consider the impacts of extreme weather and climate, and act to ensure that housing remains fit-for-purpose and comfortable for residents in the future.
- Developers and local authorities need to increase the use of green infrastructure in urban areas, to maximise its potential to reduce run-off, lower local temperatures and provide wildlife habitat.
- Review priorities for conserving and protecting threatened historical and natural heritage, taking into accounts sites that are vulnerable to climate change impacts.
- Encourage risk assessments within the health sector to take account of climate change impacts. This will help to ensure that the sector is resilient and able to provide the necessary health services, particularly to vulnerable populations such as the elderly.

Our society and infrastructure

Case study

Adapting to coastal erosion in Devon[34]

The Slapton Line, a natural shingle bank that separates the beach of Slapton Sands from Slapton Ley National Nature Reserve in South Devon, is vulnerable to coastal erosion and the effects of increased storminess and sea level rise due to climate change. Experts believe that the road that runs along the line can only be maintained for a maximum of 30 – 50 years, and possibly less if storms become more violent. This has important consequences, as this road links the community to the rest of the coastal stretch between Dartmouth and Torcross and is used by residents, visitors and delivery vans for businesses.

An adaptation plan, 'Living with a changing coast' has been developed by the Slapton Line Partnership, through consultation with local residents and businesses. This includes the followings actions to help the community adapt:

- Pre-emptive permission has been achieved for moving sections of the road inland.
- Signage for alternative routes has been agreed. A programme of systematic road improvements along the route has been started.
- A contingency plan for road closures has been developed and tested. Everyone is encouraged to check their alternative routes to school and work.
- Businesses have been taken through marketing and planning training, which focused on the challenge of the future road closure. A sustainable tourism strategy that seeks to make more of the area's natural assets was developed.
- The Business Forum is working on a number of matters, including plans for businesses to join up on distribution to lower costs.

[34]Slapton Line Partnership (2010)

Case study

Rain and shine in Looe

Andrew Gill, owner of Pendragon Crafts has lived in Looe all his life and has noticed over the years a trend towards more unsettled and extreme weather. This has created both problems and opportunities, which Pendragon Crafts must adapt to.

Periods of intense sunlight have meant that visitors to Looe are increasingly coming into the shop asking for products such as sunscreen, hats and parasols. However, Looe has also experienced big problems with flooding from more frequent intense rainfall and storm events which threaten business along the seafront, particularly when combined with a high tide. Andrew has adapted his business to this flood risk by installing a temporary flood board, which can keep out up to 18 inches of water. The local business community has also developed a cascade system to support each other. When there is a high tide alert, businesses work together to communicate the flood risk message and ensure that their flood boards are in place.

'Don't be complacent. You never think its going to happen to you… and then it does.'

Andrew Gill, owner of Pendragon Crafts, Looe

Our economy

A changing climate will present our businesses with opportunities for innovation, as well as challenges.

Although there is an increasing demand throughout the economy for products and processes that reduce carbon emissions, the need to prepare for the physical impacts of climate change tends to be less well recognised. Flooding and other extreme events can not only affect business premises, but also the infrastructure upon which they rely (such as roads, railways and utility networks), leading to a number of indirect impacts. For instance, staff, customers and deliveries may have difficulty reaching businesses, and interruptions in telecommunications, water and power supplies due to disruption from severe weather elsewhere may significantly disrupt normal business operations.

Of the 400,000 businesses based in South West England, 99 percent are small or medium size enterprises (SMEs) with fewer than 250 employees[35]. Research has shown that SMEs are most vulnerable to the impacts of climate change, but are the least knowledgeable and the least well prepared. There is, therefore, a need to support SMEs in understanding the implications of climate change and how to adapt.

The Stern Review on the Economics of Climate Change[36] showed that the benefits of strong, early action on climate change considerably outweigh the costs and that adaptation policy is crucial for dealing with the unavoidable impacts. We need to help our businesses build a stronger, more diverse and resilient economy by ensuring that the opportunities and risks associated with climate change are built into their plans and operations.

Flooding in Gloucester Docks, 2007

'Quite frankly we were very lucky that we didn't have people drown when we had six foot of water in our campsite. So you have to learn from this and you have to adapt, otherwise your business may not survive.'

Robert Kearle, Glastonbury Festival

[35]South West Regional Development Agency website (2010)
[36]The Stern Review on the Economics of Climate Change (2008)

Our economy

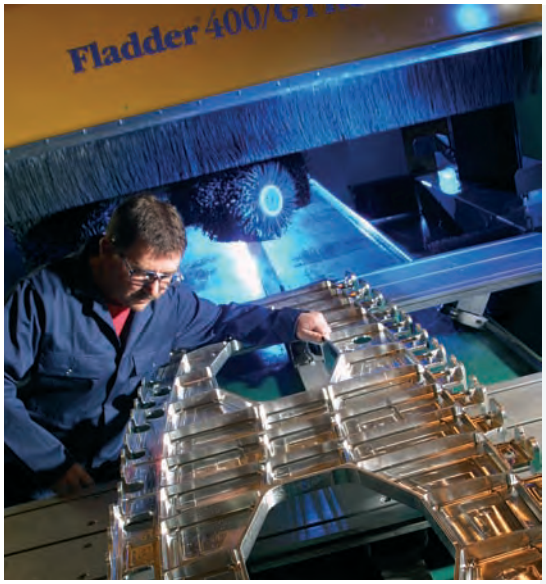
Advanced engineering and Aerospace

The South West's aerospace sector is the largest in the UK, employing 18,000 people (2007). 10 of the 11 largest aerospace companies have major facilities here, including Rolls Royce, GKN and Airbus[37]. Engine and wing design and manufacture will have to adapt to the low carbon age, balancing the increasing demand for air travel with rising oil prices and decreasing supply. However, opportunities exist to develop new products and engineering solutions.

Direct flooding of premises and disruptions to the transport, telecommunications and utilities infrastructure from severe weather are likely to have particularly significant implications for businesses in this sector. Some rely upon a small number of specialist overseas suppliers, meaning that disruption to the supply chain may also have a particularly big impact on the business. Research indicates that risks from severe weather are considered by most advanced engineering companies from an operations point of view, but only a minority translate this into planning.

Key impacts

- Opportunities exist to develop engineering solutions to climate change impacts.
- Increased costs because of restricted water supplies and changes to energy costs.
- Increased downtime from loss of telecommunications, power and water supplies during extreme climate events.
- Disruption to the supply chain caused by severe events elsewhere in the country or world.



This sector has the potential to benefit from development of new technologies in renewable energies, energy-efficient vehicles and flood defence'

Engineering company

[37]South West England website (South West Regional Development Agency 2010)

Our economy

Biotechnology

The South West is renowned across the world for bio manufacture, bio diagnostics and marine biotechnology. Significant opportunities from climate change exist for this sector, as the increased threat of food shortages, tropical diseases such as malaria, and the spread of animal pests could be solved by biotechnology.

Key impacts

- Health concerns, including increased solar radiation, heat stress and dehydration, will provide market opportunities.
- Dust and heat stress as a result of increased temperatures may have direct impacts upon some business processes and operations, causing equipment damage and downtime.
- Demand for climate resistant crops and biological processes will increase opportunities for market development.
- Severe weather impacts on transport networks will affect the speed and reliability of product procurement and delivery.

Information & communication technologies

The Information and Communication Technologies (ICT) sector has seen massive expansion in recent years and is an important contributor to the South West's economy. Large international companies have located in the South West and led to the development of smaller businesses providing software, equipment and other products and services.

Key impacts

- Damage to infrastructure, and consequent costs, particularly communications masts and overhead cables.
- Increased downtime from loss of energy supplies and telecommunications during extreme weather.
- Increased market for technologies in mitigating and adapting to climate change, e.g. monitoring building temperatures and flood risks.
- The capacity of ICT networks will be put under increased pressure during periods of extreme weather (for instance, due to more people working from home and connecting to computer networks remotely). Network capacity therefore needs to be improved.

Our economy

Environmental technologies

Our excellent natural resource and world leading strengths in areas such as marine environmental technologies are well recognised and in 2009 the South West was designated the UK's first Low Carbon Economic Area in recognition of our leading work in the Marine Energy sector.

The South West hosts some of the best solar, deep geothermal and marine resource in the UK alongside extensive biomass and wind. This abundance of natural resource, combined with good grid capacity and an innovative and dynamic business base, has delivered many UK firsts, from the first commercial windfarm in the UK at Delabole to the world's first commercial scale Marine Current Turbine off the North Devon Coast. As well as two major offshore wind farm developments, innovative projects such as Wave Hub in Cornwall will cement the South West's reputation as being at the forefront of environmental technologies.

Solar panels at Dunster Castle

Key impacts

- Significant opportunities for developing and selling products and services to monitor, mitigate and adapt to the risks of climate change.
- Renewable energy and increased solar radiation provides opportunities for localised power generation. This has the potential to reduce energy costs and increase resilience to the vulnerability of transporting power.
- Increased demand for consultancy services in managing climate impacts.
- Increased resource costs, including fossil fuel-based materials, and increased business costs due to changes in global markets and disruption from severe weather.

'Plan for future climate change and don't be frightened to bang the drum and get some publicity for being pro-active – it's usually free marketing!'

Peter Hickling, High Post Golf Club

Our economy

Financial services

The financial services sector in the South West is one of the largest outside London[38]. Insurance companies are potentially vulnerable to the impacts of climate change, as shown by the extensive claims they face following severe floods. However, the insurance industry is very well-informed about the impacts of climate change and is working to increase customer awareness of the risks and to encourage adaptation.

Financial institutions need to safeguard their investments by evaluating how climate change could affect businesses and properties and by employing their potential to influence adaptation action by their customers.

Key impacts

- Insurance companies are highly vulnerable to large losses from storms, droughts and floods – both locally and globally.
- Warmer winters will reduce cold weather-related insurance claims, but there could be more subsidence claims in drier summers. Health impacts on those insured under health insurance schemes could also be significant.
- Banks and building societies may lose income as customers incur losses from climate impacts such as disrupted supply chains.
- Properties in high risk areas, primarily flood plains and along unstable coasts, will lose value, and may become uninsurable or unsaleable, resulting in losses for lending institutions.

Climatewise

Through the ClimateWise initiative, insurers from around the world are coming together to raise awareness about climate risks and to help customers and governments reduce the risks they face as a result of climate change.

ClimateWise
REDUCING THE RISK FOR TOMORROW

www.climatewise.org.uk

[38]South West Regional Development Agency website (2010)

Our economy

Food and Drink

The South West is one of the strongest food and drink producing areas in the UK, renowned throughout the world for the quality of its produce. With "food miles" and sustainability of food production an increasing concern, this sector will play an important part in the development of the South West and UK economy.

The food and drink sector is closely linked to, and even reliant upon, the weather and climate. Therefore, changes to both the average climate and the frequency of extreme weather will have a number of implications for businesses in the sector.

Key impacts

- Cooling methods need to be enhanced to avoid damage to produce and reduce bacterial build-up as temperatures rise.
- Changes to food and drink consumption patterns, including increased demand for ice creams, cold drinks and salads in summertime.
- New product opportunities, such as increased wine production. A potential increase in visitor numbers to the South West in warmer weather also means a larger market, particularly for local specialities.
- Impacts on agriculture and fisheries, including changes to fish spawning and heat stress on animals, will have a knock-on effect for other businesses in the food and drink industry.

Our economy

Marine

As you would expect from a region where no place is more than 40 miles from the sea, the South West leads the world in marine research, both in the leisure and industrial sectors.

Sea level rise and increased storminess will bring a number of challenges for organisations that rely on our coasts and seas. However, opportunities also exist to harness that energy, develop new technologies and offer new services for those both working in, and enjoying, the marine environment.

Key impacts

- Opportunities to develop engineering solutions to climate change impacts in coastal zones, including new technologies to accommodate changes in sea levels and storm surges.
- Affects of sea level rise and potential increases in storm surge on infrastructure, particularly coastal-based facilities, supply lines and customers, will be acute.
- Opportunities to develop offshore and coastal renewable energies such as wind power and tidal barrages.
- Increased outdoor leisure will fuel demand for boats and other marine services.

Our economy

Tourism and leisure

Tourism plays a vital role within the South West's economy, with over 118 million visitors (21.2 million overnight visitors and 96.8 million day visitors) in 2008, spending over £9 billion. Tourism supports about 200,000 full-time jobs in the South West[39].

The South West's beautiful and historic landscape is a key asset in attracting visitors, with 2 National Parks, 14 Areas of Outstanding Natural Beauty (including Britain's largest, the Cotswolds), more than two thirds of England's heritage coast and a high proportion of the UK's rarest and most endangered habitats. Its built environment includes 35% of the country's scheduled monuments, 24% of all listed buildings and four World Heritage Sites[33].

The importance of tourism to the South West means it is vital that we ensure the industry is resilient to the effects of climate change and well-placed to make the most of potential opportunities from a longer tourist season and increased visitor numbers. It will also be important to safeguard the natural environment from the increased pressure that higher visitor numbers would bring.

A survey of tourism businesses in the South West found that 56% had been affected by extreme weather events in the past. However, only 46% had implemented any of the given adaptation measures and 47% see preparing for change as a low priority[40]. It is, therefore, important to effectively communicate the issue to businesses, highlighting the vulnerability of the industry to extreme weather both now and in the future.

> *'The heatwave in August 2003 brought high temperatures of 31+°C attracting record numbers of visitors to Bournemouth and Poole leading to accommodation that was full and beaches that were packed. However it also pushed local infrastructure, facilities and services to its limits.'*
>
> **South West Tourism UKCP09 case study**[41]

[39]Value of Tourism survey (2008)
[40]Tourism Business Survey 2010 (Cheung, E. and Dinan, C. (University of Exeter) for Climate South West and South West Tourism 2010)
[41]Cost-a South West: What could tomorrow's weather and climate look like for tourism in the South West of England? (Whittlesea, E. and Amelung, B. for South West Tourism, 2010)


© Bournemouth Tourism

Key impacts

- Longer, warmer summers and milder winters could extend the tourist season. Extreme high temperatures in Mediterranean and other overseas tourism areas could also increase both domestic and international tourism to the South West.
- Rising sea levels, flooding and coastal erosion threaten many beaches and coastal and riverside amenities. Heavy rainfall can also have an impact on bathing water quality (and, therefore, related beach tourism) due to harmful organisms being washed into the sea.
- There will be health implications for visitors and outdoor workers, due to an increased risk of heat stress, food poisoning and exposure to the sun.
- Increased visitor and climate related pressures on the natural environment, attractions, services and utilities.

Our economy

Recommendations and actions

- Businesses to carry out climate change risk assessments and develop plans to exploit opportunities and minimise risks, using tools such as UKCIP's Business Areas Climate Impacts Assessment Tool (BACLIAT) and the 'Preparing for Change: climate-proof your tourism business' at www.climateprepared.com.
- Business and industry should explore commercial opportunities in the South West, recognising that markets will be influenced by climate change impacts on regional, national and global scales.
- The financial sector needs to build climate change risks into investment decisions, developing this into a widespread practice.
- Key business infrastructure operators in the South West, including transport, energy and telecommunications networks, should work to develop greater resilience to extreme weather and climate impacts.
- Tourism agencies and associations to monitor the impact of changes in temperature and extreme weather on visitor numbers, and support tourism destinations in the South West to plan ahead to address the implications of this.

Our Local Authorities

Local Authorities have a key role in preparing for extreme weather and climate change and adapting to its impacts. The Nottingham Declaration website identifies three principal roles for local authorities in relation to climate change:

i. As service providers local authorities are responsible for a range of functions which include: Planning, Transport, Building Control, Social Services, Education, Waste Management, Economic Development, Emergency Planning….

ii. As corporate managers councils have responsibility for all of the functions that fall upon any large organisation for managing their own operations (e.g. buildings and estate management, vehicles, environmental management, risk management, health & safety etc).

iii. As community leaders councils are called upon to be pro-active in demonstrating leadership whilst demonstrating good practice. The effective response by local areas to the challenge of climate change impacts provides an important leadership role for local authorities. This involves working with strategic partners and the local community.

In 2010, Climate SouthWest coordinated a project, funded by the South West Improvement and Efficiency Programme, which supported 9 local authorities to complete a Local Climate Impacts Profile (LCLIP). An LCLIP is a simple tool designed to help organisations assess their exposure to weather and climate.

The project identified hundreds of impacts from extreme weather across the local authorities. These included; service disruption, school closures, increased insurance claims; disruption to transport networks and increased pressure on emergency services. These findings helped to raise awareness within local authorities of the issues and highlighted the importance of ensuring that local authority operations are as resilient as possible to the impacts of extreme weather.

The completion of LCLIPs has contributed to the good progress made in the South West against National Indicator 188: 'Planning to adapt to climate change', which was part of the local government Performance Framework between 2008 and March 2011. 98 % of local authorities in the South West have also signed up to the Nottingham Declaration on climate change, showing a positive commitment to act. Adapting to extreme weather and climate change must be an ongoing process if the negative consequences for local areas are to be minimised. It is, therefore, essential that local authorities continue to integrate adaptation into their operational practices.

Recommendations

The following are recommendations for areas where local authorities can initiate change:

- Support and utilise national programmes on climate change adaptation, activity under the Climate Change Act, and national guidance provided by the UK Climate Impacts Programme (UKCIP), the Local Government Association (LGA) and Defra.
- Encourage officers across local authority departments to improve understanding of climate change through their networks of professional bodies, local government officers and the LGA. For example, through Planners and the Town and Country Planning Association and Risk Managers and Local Resilience Forums.
- Encourage all tiers of local authorities and relevant partnerships to share best practice in both technical and managerial aspects of adaptation and to utilise training and tools available through Climate SouthWest and UKCIP on adaptation and use of UKCP09 scenarios.
- Integrate climate change work and adaptation responses into appropriate strategic and policy frameworks, such as Local Development Frameworks, Local Transport Plans, community strategies and the emerging Local Enterprise Partnerships.
- Work with local communities to help them understand the implications of extreme weather and climate change and how to prepare.

The Way Forward

Climate SouthWest is committed to taking forward work to address the issues detailed in this report. The Partnership continues to work to ensure that climate change is considered and built into strategic plans at the sub-national and local level. It also encourages businesses and organisations across the South West to assess their risks and develop appropriate and sustainable adaptation responses.

Evaluating risks and opportunities, and identifying adaptation options, is part of an ongoing and cyclical process to ensure the South West is in the best position to make real progress towards adapting to climate change.

Effective communication of the messages in this report is a challenging task and must be a continuous and ongoing effort. Many businesses and organisations have limited time and resources and do not see adapting to climate change as a high priority. However, adaptation is not just an issue for the future. The South West's environment, society and economy are already affected by extreme weather, making it essential that adaptation is integrated into normal business practices now.

Local authorities, businesses and other organisations across the South West are encouraged to use the messages from this report to embed adaptation to the risks and opportunities of extreme weather and climate change into their own organisational practices. Raising further awareness of the issues through communicating with their networks and influencing those that they do business with, will also be key to helping create a resilient South West.

Further information about climate change impacts and adaptation in the South West can be found on the Climate SouthWest website: www.oursouthwest.com/climate

Recommendations for Climate SouthWest

- Continue to act as a **focal point** for information on climate change impacts, adaptation and current work in the South West.
- **Influence** the development of local authority and Local Enterprise Partnership work programmes, and facilitate linkages with relevant organisations where appropriate, to ensure that climate impacts and adaptation are considered across the South West.
- **Increase awareness** of the need for adaptation in businesses across all sectors. Although the issue is starting to gain greater recognition, many stakeholders are still not fully aware of the implications of climate change for them, and few are taking action to increase resilience.
- **Encourage and support** all organisations to identify appropriate mechanisms, such as risk management and business continuity management processes, within which to incorporate adaptation strategies.
- **Improve communications** across the Partnership and convey clear messages to the media and key stakeholders to help raise awareness of climate impacts and adaptation.
- **Develop and disseminate** additional case studies showing good adaptation practice, in order to help organisations understand how they might go about preparing for climate change.

AGRICULTURE, HORTICULTURE AND FORESTRY

Opportunities

- Longer growing season providing increased yields
- Potential for new crops (e.g. grapes, navy beans, sweetcorn, soya and sunflowers)
- Reduced frost damage should increase productivity
- Potential increased growth rate (e.g. for forest trees)
- Opportunities for new forestry planting in floodplains to mitigate flooding

Challenges

- Reduced die-off of pests and diseases due to warmer winters
- Decreased soil quality and increased erosion due to increased run-off from winter precipitation
- Need for increased irrigation in summer
- Possible wind and storm damage to standing crops and nursery stock
- Increased heat stress to poultry and livestock

COASTAL ISSUES & MARINE FISHERIES

Opportunities

- Increased tourism in coastal zones may boost local economies
- Increased marine activity, water sports, surfing etc
- Increased scope for aquaculture of new species of fish and shellfish
- Some fisheries may be enhanced by increased breeding season

Challenges

- Increased rate of coastal erosion and silting of estuaries
- Loss of natural assets in the coastal zone e.g. wetlands and beaches
- Reduced overall productivity of oceans, and loss of some commercial species (fish and shellfish)
- Deterioration in water quality and increase in algal blooms
- Increased run-off and leaching from land damaging to flora and fauna in coastal zones
- Pressures arising from increased tourism in coastal zones

BIODIVERSITY

Opportunities

- The arrival of new plants and animals from the south boosting eco-tourism
- Integrated land management to regulate coastal and river flooding, improve water quality and store winter rainfall in new wetlands
- Re-establishment of coppicing, thinning, and pollarding in woodlands, increasing structural, and therefore species diversity
- More trees, particularly in villages, towns and cities, to regulate rising temperatures, flooding and air quality

Challenges

- Ensuring that species, particularly those most critical for natural processes, can move to occupy suitable habitat within their new 'climate space'
- Increased visitor pressure on natural environment
- Loss of coastal and marine habitats due to increased rate of coastal erosion, the rapid spread of new invasive species, and siltation from the land.
- Increased incidence of fire in hot dry summers leading to loss of peat which supports heathland and mire habitat/species

RIVER FLOODING AND DRAINAGE

Opportunities

- Expansion of sustainable urban drainage systems
- Commercial opportunities in flood defence and flood management
- Opportunity to integrate estuarine and coastal flood defence

Challenges

- Increased risk of flooding from increased rainfall
- Improvements and higher specification required for flood defences
- Improvements and higher specification required for urban drainage and rainwater disposal systems

WATER RESOURCES AND WATER QUALITY

Opportunities

- Increased supply available in winter but needs capturing and storing
- Greater potential for one-season recharge of larger reservoirs and aquifers
- Greater potential in winter for increasing water releases to hydropower

Challenges

- Increased evaporative losses from surface water stores
- Increased demand for water in summer
- Higher concentrations of pollutants in watercourses from reduced summer rainfall
- Increased risk of algal blooms and pollution in reservoirs with reduced water levels and low inflows in summer
- Potential for saline incursions into coastal water abstraction plants and boreholes
- Increased risk of sediment and pollution runoff into watercourses

BUILT ENVIRONMENT & HOUSING

Opportunities

- Reduced heating demand, especially in winter, and therefore reduced heating costs
- Commercial opportunities for developing expertise in passive solar heating, cooling, shading and other environmental technologies
- Increased scope for outdoor activities around buildings, especially in summer
- Increased potential for renewable sources of energy (e.g. passive solar)
- Increased need for shading (e.g. more trees in urban streets and squares)

Challenges

- Planning and design of new buildings in locations vulnerable to flooding
- Potential overheating of interior environment in existing and new buildings in summer will require sustainable solutions to cooling
- Increased subsidence and associated insurance claims due to drying out of substrata (especially in clay areas)
- Increased summer demand for water
- Design standards will need to be revised in light of new climate scenarios

TRANSPORT

Opportunities

- Increased scope for walking and cycling for everyday travel and tourists
- Improved rail and road infrastructure to provide alternative and diversionary routes in case of extreme climate events
- Less frost damage to roads from winter cold; less need for road salting
- Fewer ice/snow related accidents on roads and footpaths
- Fewer ice/snow related points failures on railways

Challenges

- Increased pressure on transport systems from more tourists
- Flood risks to roads in some major towns and flash floods disrupting roads
- River/coastal flooding and landslip threats to railways
- Some disruption to air traffic (e.g. air links to Scilly Isles and from Cornwall to London)

UTILITIES

Opportunities

- Reduced heating demand, especially in winter may lead to lower bills for consumers
- Commercial and environmental opportunities for developing renewable energy production (wind, tidal, bio-mass, bio-fuels, solar)
- Commercial and environmental opportunities for passive solar heating, cooling, shading and other environmental technologies
- Increased potential for renewable sources of energy (e.g. passive solar)

Challenges

- Increased tourism, in summer and winter, will increase demand on utilities
- Potential summer overheating of buildings will require sustainable solutions to cooling
- Utilities infrastructure is vulnerable to flood damage in some locations
- Increased demand for water in summer

HEALTH

Opportunities

- Reduced winter mortality (e.g. from hypothermia)
- Healthier lifestyles due to increased opportunities for outdoor activities
- Fresh, healthy and locally-produced food available for a longer period
- Less risk of injury due to falls on ice

Challenges

- Increased risk of food poisoning
- Increased risk of sunburn, heatstroke, and exposure to UV radiation (skin cancer)
- Increased risk of heat exhaustion and dehydration in summer
- Risk of deterioration in water quality and increase in infection
- Higher air pollution in urban locations leading to respiratory disease
- Increase in some diseases (e.g. Lymes disease from ticks)

TOURISM AND LEISURE

Opportunities

- Longer, drier summers leading to increased visitor numbers and visitor spend
- Warmer winters, leading to a more year-round tourist season
- Development of new tourism markets, services and products e.g. more outdoor and water-related recreation
- Potential increase in UK holidays, urban tourism and city breaks as Mediterranean destinations become too hot

Challenges

- Increased demand on transport and utilities infrastructure due to increased visitor numbers
- Coastal attractions vulnerable to sea level rise
- Increased visitor pressure on natural environment
- Risk of visitors exposed to sun and heat related illness
- Threats to natural landscapes and historic gardens if species cannot adapt to changing conditions and emerging pests
- Flood damage to tourism businesses and infrastructure, especially vulnerable sites such as camping and caravan parks
- Increased liability and insurance costs for businesses

ENVIRONMENTAL TECHNOLOGIES AND BIOTECHNOLOGY

Opportunities

- Commercial and environmental opportunities for passive solar heating, cooling, shading, pollution monitoring and other environmental technologies and expertise
- Increased demand for 'greywater', water treatment and new water-efficient technologies and expertise
- Genetic modification of crops (e.g. to resist summer drought, winter rain, and related pests)
- Develop preventive measures to deal with stronger sun

Challenges

- Operational difficulties for equipment at high temperatures
- Changes to water supply and quality will restrict water intensive activities
- Heat stress on some business processes and operations, causing equipment damage and downtime
- Increased downtime from loss of telecommunications and energy supply during extreme weather.

FINANCIAL SERVICES

Opportunities

- Reduced insurance claims arising from cold weather conditions
- Investment opportunities resulting from increased economic activity (e.g. tourism)
- Investment opportunities resulting from new market opportunities (e.g. environmental technology)

Challenges

- Increased insurance risk due to flooding, landslips and subsidence
- Higher insurance costs generally and potential for insurers not to provide cover to certain locations, premises, and activities
- Banks and building societies may lose income as clients incur losses from climate impacts
- Increased marine and offshore impacts and related investment and insurance losses

FOOD AND DRINK

Opportunities

- Availability of new crops and species in the region, reducing import costs
- Developing new markets for local produce, especially new local varieties
- Increased consumption of warm weather food and drinks leading to new markets

Challenges

- Increased demand for cooling with associated environmental and financial costs
- Increased bacterial build-up in foods leading to health risks and associated litigation
- Loss of some traditional species and crops
- Impacts on transport infrastructure especially ports, affecting distribution to and from markets

Further Information

This report updates the 'Warming to the Idea: meeting the challenges of climate change in the South West' summary report, which was commissioned by the Climate SouthWest partnership (then known as the South West Climate Change Impacts Partnership) in 2003. This update also draws upon stakeholder-led scoping study carried out on behalf of the Partnership.

The original South West Climate Change Impacts Scoping Study was carried out by:

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Designed by **Nadolski** 01392 496200

Further Information

Copies of 'Warming to the idea', the South West climate change impact scoping study can be found at www.oursouthwest.com/climate

For Further information visit www.oursouthwest.com/climate or email climatesw@environment-agency.gov.uk