



**Climate**SouthWest

# Business Vulnerability to extreme weather in the South West: Understanding the baseline

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# 1. Executive Summary

This report was directed by Climate SouthWest to evaluate business vulnerability to weather-related risks across key business sectors in the South West of England. Interviews were conducted with a number of representatives from four key sectors that had been identified by Climate SouthWest on a combination of factors. The key sectors chosen were; advanced engineering; transport and distribution; food and drink manufacturing; and construction.

The report examined the impacts on businesses in the South West that arise from three weather-related risks; flooding/heavy rain; water shortage; and high temperatures. Both direct and indirect impacts were assessed to create a high level cross-sectoral regional picture of vulnerability and resilience to climate change and weather-related impacts.

The report found that vulnerabilities to weather-related risks varied from sector to sector, but was generally highest for flooding. Water shortages were a particular concern for food and drink manufacturing businesses but were not a key concern for other sectors. Vulnerabilities to high temperatures were perceived as relatively low.

Vulnerabilities to service/utility networks also varied both inter and intra-sectorally and depended on a number of factors, most notably preparation for disruption and business planning. Road networks were seen as carrying the highest levels of risk, with many businesses highly vulnerable to disruptions while power and telecommunication disruptions were also widely viewed as carrying high levels of risk.

Supply chains of South West businesses are viewed as relatively complex, particularly amongst the advanced engineering and construction sectors where they carry a strong international dimension. This complexity translated into a high level of supply chain vulnerability across all sectors with the exception of construction, where many chains are secure or there are backup options available. The loss of certain key suppliers is of great risk to businesses across all sectors and threatens to disrupt or halt business operations and production. In the case of many businesses in the South West this risk is elevated by a lack of supply chain continuity management and dual-sourcing.

The geographical location of businesses is a key indicator to vulnerability, particularly with regards to flooding and access. Due to the coastal and low-lying location of many business centres in the South West this is a key concern to the region and places a significant emphasis on the need for businesses to take adaptation measures and include risk assessment in their planning processes.

All vulnerabilities intensify as the length of disruption increases. While the effect of short-term disruptions is largely dependent on a business' ability to

absorb short-term losses, long-term disruptions pose a risk to all sectors with different levels of vulnerability expected depending on the type of disruption and levels of preparedness.

The report found that while many vulnerabilities were considered to be quite significant there was an underlying theme that disruptions carried a low probability. This level of risk is exacerbated by the lack of business continuity planning and risk assessment that is prevalent among many businesses, particularly small and medium enterprises. Many businesses across the four key sectors examined are unaware of their vulnerability to weather-related risks and the impacts of climate change. There is a significant lack of awareness prevalent amongst South West businesses relating to;

- the current changing climate of the South West;
- their vulnerability to direct impacts and the extent of damage that these impacts could have on stock and infrastructure;
- their vulnerability to indirect impacts and the effect that disruptions to utilities or supply chains may have on their operations;
- the nature of these vulnerabilities;
- and the adaptation measures available to increase resilience to disruptions.

The extent of activity on climate change adaptation by business support organisations appears relatively low. Assistance to businesses is largely limited to planning for sustainability or responses to problems that have already occurred. There is an urgent need for business support organisations to help businesses in the South West understand and plan for the potential impacts of future climate change and help increase awareness amongst them of the risks that they face if they are to remain resilient to weather-related impacts and climate change.

## 2. Introduction

In 2009, Climate SouthWest (formerly South West Climate Change Impacts Partnership) established a Business and Utilities Sector Group. The groups membership included representation from; businesses, utility companies, academics, the South West Regional Development Agency (SWRDA), Business Link, the Environment Agency, the Federation of Small Businesses, Global Action Plan and Business in the Community. The group's aim is...

*'To engage businesses throughout the South West in addressing their vulnerability to the effects of climate change and maximising the opportunities that arise'.*

The group proposed a project to examine the vulnerability of businesses in the South West of England to climate change, in order to inform their future work.

## 3. Project Description

*Aim: To evaluate business vulnerability to weather-related risks across key sectors in the South West of England.*

The project seeks to achieve this aim by identifying **a)** the types of businesses (in terms of size, sector and location type) which are particularly vulnerable (or resilient) to weather-related risks and **b)** the nature of that vulnerability. This will help to provide a baseline understanding of current levels of vulnerability to the impacts of extreme weather, which are expected to increase as our climate changes.

The project analysis will include consideration of both the direct impacts of extreme weather (e.g. flood damage) and the indirect impacts (e.g. loss of water/power supply or disruption to supply chains due to weather events elsewhere). While it is recognised that a particular business' vulnerability to climate change will depend on a number of factors, this project will focus primarily on the sensitivity of businesses to disruption from extreme weather events.

Consideration of the types of locations which may make a business more vulnerable (e.g. rural/urban, coastal/inland) may be included in the project, but identification of specific geographic locations at risk is *not* a key component of the study.

The report draws on Climate SouthWest knowledge and experience, an in-depth literature review, interviews with key sector contacts and similar projects completed by other groups and organisations. It is intended to answer the following questions:

1. What business types in the South West are most affected by:
  - a) Direct impacts of future climate change
  - b) Indirect impacts of future climate change in the UK
2. What is the nature of the vulnerability? (E.g. disruption to supply chain / loss of power / flood damage)
3. Which resources / supplies would have the most impact on business if lost?

By answering these questions it will be possible to begin to understand business vulnerability to extreme weather across key business sectors and help to:

- a) Increase Climate SouthWest's (including Business Link and SWRDA) understanding of the levels and nature of business vulnerability in the SW (i.e. which types of business and business processes are most vulnerable to climate-related risks).
- b) Inform how resources and support provided through the Business and Utilities Sector Group are targeted.
- c) Identify priority business audiences for Climate SouthWest, Business Link and SWRDA communications regarding climate adaptation.

The purpose of the report is to assist Climate SouthWest's Business and Utilities Sector Group in identifying the direct and indirect vulnerabilities that businesses in the South West of England may face over the coming decades. The project itself is not primarily intended to assist a wider business audience.

## **4. Rationale and background**

The UK Climate Projections 2009 (UKCP09) highlight both the trends of recent changes to the UK's climate and project the changes we are likely to see in the future. In addition to reducing the causes of climate change by cutting greenhouse gas emissions, it is also vital that we adapt to the impacts of a changing climate, in order to minimise the costs and maximise any opportunities. The issue is increasingly being recognised through policy and legislation; for instance, the UK Climate Change Act became law in November 2008 and the European Commission published its White Paper on Adapting to Climate Change in 2009.

Climate change is bringing warmer temperatures, sea level rise and more intensive and frequent extreme events to the South West. Although single events - like a flood, heat wave or drought - are not in themselves proof of climate change, they are set to become more frequent and intense in the future. The implications of climate change are felt beyond the direct effects of weather on buildings and operations. Climate change poses both risks and opportunities for business but there is concern that, unless the changes are

prepared for, businesses will be increasingly adversely affected and will not be able to maximise any advantages. Climate change should, therefore, be an integral component of long-term planning for all businesses.

Vulnerability is determined not only by a business' exposure to climatic effects, but also by their level of preparedness. For instance, a business which has developed a Flood Response Plan and taken steps to protect its buildings from flooding, may be more resilient than one which has not, even if it is situated in an area with higher flood risk.

A number of factors such as business knowledge and planning, past exposure to events, and available resources may influence levels of business resilience. However, little research, that Climate SouthWest is aware of, has been done to assess how resilient or vulnerable businesses in the South West are to the impacts of climate change.

The South West has an above average proportion of Small and Medium-sized Enterprises (SMEs). Certain features of SMEs, such as a tendency for short-term business planning and a lack of capital, may mean that they are more vulnerable to the impacts of climate change than larger businesses. The challenges posed by climate change vary in nature between different business sectors and sizes. Attitudes towards climate change and levels of adaptive capacity may also differ, thereby affecting the extent to which preparatory measures have been taken.

A greater understanding of these variations in vulnerability levels between types and sizes of businesses is sought, in order to most appropriately and efficiently target resources. This will also create a baseline against which future progress can be measured.

Vulnerability may be seen as a component of risk and itself a function of exposure, sensitivity and adaptive capacity. By taking this construction of vulnerability this study acknowledges that it will be examining one aspect of vulnerability (i.e. how exposed are the different business sectors in the South West) to extreme weather and climate change. It is also recognised that there are a number of factors that affect the vulnerability and exposure of a business such as physical features of locality, supply chain features, physical assets, market features, institutional/governmental arrangements and people. Due to time restraints this project focusses solely on knowledge of and preparation for disruptions to utility provision and supply chains.

Of the 400,000 businesses based in South West England 99% are SMEs (less than 250 employees) (SWRDA, 2010). On top of this 73% of private sector employment in the South West is in SMEs, compared to the 58% national average (BIS, 2009). The regional economy was worth £97.8 billion in 2008 and made up 7.8% of the total UK economy (SWRDA, 2010).

Contributions of the four selected sectors to the South West economy in 2009 were as follows;

	Contribution to SW GVA (%)	Employees
Engineering	1.3	28,044
Transport & distribution	5.6	119,839
Food & drink manufacturing	1.6	39,978
Construction	7	194,056

Table 1: key sector GVA contribution and employee statistics

## 5. Methodology

The following methodology was used for the project.

1. Review of relevant literature
2. Selection of key sectors to focus on and qualitative interviews with key sector representatives
3. Preliminary risk assessment of vulnerability across key businesses sectors to the impacts of:
  - a. Flooding/heavy rain
  - b. Water shortages
  - c. High temperatures

### 5.1. Literature review

An extensive literature review was carried out to identify key sectors, business types and impacts. The literature review (Appendix 1) drew on information from a number of sources including UK non-government agencies, sector support organisations and international organisations.

The findings of the literature review were analysed by the Business and Utilities Sector Group to refine the scope of the project.

### 5.2. Selection of key sectors

Four key sectors were chosen by the Business and Utilities Sector Group based on a combination of factors including; Regional Development Agency priority sectors; share of gross value added from the regional economic strategy evidence base; sectors that have been identified in other regions' reports as

particularly vulnerable; and existing knowledge and engagement of a sector within the group.

The four key sectors chosen are as follows:

- Advanced Engineering
- Transport and Distribution
- Food and Drink Manufacturing
- Construction

### ***5.3. Interviews***

Telephone interviews were conducted with key representatives from each of the selected sectors. Despite initial consideration, individual businesses were not interviewed due to a lack of contacts, difficulties in obtaining interview times, and a biased sample due to the group's contacts being those who were more likely to have taken climate change action. The majority of contacts were identified by the Business and Utilities Sector Group while others were identified throughout the interviews on recommendation of the interviewees.

The interviews were structured around twelve questions (Appendix 2) on business practices, experiences and awareness relating to direct and indirect impacts of severe weather events. Certain questions were left open to allow the participant to expand on issues that they felt were particularly relevant or bring in issues that were relevant to their sector. Some closed questions were also used to gain clear responses that could be cross-referenced across the interviews to pick out trends. Such questions included rating the seriousness of impacts and disruptions on a sector from on a scale of one to five (one being low, five being high).

### ***5.4. Risk assessment***

Following the interviews a risk assessment of the key sectors was completed using the findings from the literature review and interviews, as well as being informed by the knowledge and experience of Climate SouthWest Business & Utilities Sector Group members. This risk assessment is summarised in tables two to four in the findings section six.

## **6. Literature Review**

### ***Introduction***

This literature review will focus on previous academic and non-academic reports, case studies and articles to identify the direct and indirect effects of severe weather and other climate related events on businesses.

The purpose of the literature review is to provide a solid grounding of knowledge to explore the vulnerability of businesses in the South West of England to the related impacts of climate change, their readiness, capacity and need to adapt.

The review will be structured around a number of key areas relating to the potential direct and indirect impacts on businesses, vulnerability of businesses to the potential impacts, and the nature of this vulnerability.

Vulnerability may be seen as a component of risk and itself a function of exposure, sensitivity and adaptive capacity. By taking this construction of vulnerability this study acknowledges that it will be examining one aspect of vulnerability (i.e. how exposed are the different business sectors in the South West) to extreme weather and climate change. It is also recognised that there are a number of factors that affect the vulnerability and exposure of a business such as physical features of locality, supply chain features, physical assets, market features, institutional/governmental arrangements and people. Due to time restraints the project will be focussing solely on knowledge of and preparation for disruptions to utility provision and supply chains.

Of the 400,000 businesses based in South West England 99% are small and medium enterprises (SMEs) (less than 250 employees) (SWRDA, 2010). On top of this 73% of private sector employment in the South West is in SMEs, compared to the 58% national average (BIS, 2009). The regional economy was worth £97.8 billion in 2008 and made up 7.8% of the total UK economy (SWRDA, 2010).

## ***Climate change***

The science behind human influenced climate change has been widely accepted by the scientific community and increasingly the public sector. A number of key reports such as the Intergovernmental Panel on Climate Change's (IPCC) 2007 Climate Change report have documented the changes in climate over the past, particularly the last 30 years, and suggested that changes in the global climate are likely to continue in the foreseeable future, with the potential to bring about an increasing frequency of severe weather events as the global climate changes (IPCC, 2007).

Climate change is a long term trend and its affects are relatively new. There are uncertainties concerning the precise magnitude, variability and rates of climate change but the overall direction of change is widely agreed upon by major governments and organisations (IPCC, 2007; UKCIP, 2009; Hadley Centre, 2005). Long term changes in average conditions and seasonal variations could exacerbate the changes currently being seen in the global climate through various feedback loops (Hartmann, 1994).

Previous studies by the UK Climate Impacts Programme (UKCIP) have acknowledged that future climate change could significantly affect the UK's private sector (UKCIP, 2009a; UKCIP, 2009b).

The incidence of severe weather events is increasing in a number of parts of the world, with the UK expected to see more floods, more storms, drier summers, wetter winters, higher sea levels and decreases in soil moisture and fertility (UKCP09, 2009). The UK Climate Projections 2009 also calculate extreme weather events becoming much more frequent and of greater amplitude with 29% of summers by 2050 being 37% drier and 3% of winters being 66% wetter.

Average global temperature has been rising steadily leading to a 0.6°C increase in the last century alone and the UKCP09 central estimate is for a further 1.6°C increase over the next 10 years in the South West (UKCP09, 2009).

Wetter winters are anticipated to increase by up to 15% by the 2020s and 25% by the 2050s, with a central estimate of a 17% increase in winter rainfall and 20% decrease in summer rainfall in the South West (UKCP09, 2009). Projections also anticipate a doubling of the number of heavy rain days (>25mm) by 2050 with the wettest days of the year seeing an increase in rainfall by as much as 40% (UKCP09, 2009). There is a strong chance that this could lead to increased winter flooding and consequential service disruptions to businesses. The River Severn central estimate of sea level rise is around 10 and 20cm for 2020 and 2050 respectively (UKCP09, 2009), which, while not immediately placing many businesses under threat, increases the risk of flooding from extreme weather events.

Results from the Met Office show that surface sea temperatures have risen, leading to a gradual thermal expansion of the oceans and a resulting increase in sea level of about 1mm per year throughout the 20<sup>th</sup> Century (Jenkins *et al*, 2008). Jenkins *et al* also point out that extreme high sea levels have risen at a faster rate of about 2.1mm per year. Changes in sea level put coastal businesses at greater risk from flooding and increase the chance of service disruptions.

Severe windstorms have also increased in number across the UK and are expected to occur with more severity across the UK and Europe (Jenkins *et al*, 2008).

The impact of extreme weather events on businesses can be massive, as the severe gales in January 2002 demonstrated where £150 million damage was caused (UKCIP, 2009b). Impacts can include; direct costs, indirect costs, uninsured costs, business interruptions and damage to reputation. Businesses are more vulnerable where they are currently affected by the weather, at risk from the impacts of extreme weather patterns such as floods, or have global

markets or supplies (UKCIP, 2009b; CBI, 2009; CIBSE, 2005; Sussman & Randell Freed, 2008; YHCCA, 2009).

### ***Direct effects***

Research by the Engineering and Physical Sciences Research Council (EPSRC) shows that in developed economies such as the UK, the greatest impact upon buildings and infrastructure will be associated with flooding/landslides, sea level rise, heat waves and water shortages (EPSRC, 2003).

A Climate South East study (2008) investigating SMEs affected by extreme weather events (including flooding, high temperatures, wind and low temperatures) found that the most commonly reported consequences were; damage to property, reduced customer visits, reduced trade and impacts on staff travel.

### Rainfall and flooding

Over the past few years there have been a number of severe floods, including the widespread floods in summer 2007. The 2007 floods are estimated to have cost UK businesses in excess of £3 billion through damage, disruption and lost business. There were also road damage costs of £32 million and power disruption costs of £25 million in Gloucestershire (Environment Agency, 2010).

Higher volumes of rainfall in winter could lead to increased levels of flooding where businesses are geographically exposed (UKCIP, 2009b). Improved flood-proofing techniques may be required by businesses in flood risk zones to limit the damage of flooding (EPSRC, 2003). Increased rainfall could also lead to significant changes in the water table, having negative impacts on buildings that have foundations or structures that sit in groundwater and increasing the risk of flooding or other water damage (EPSRC, 2003).

Wetter winters pose many challenges for the infrastructural design of buildings, including damp, condensation and damage from driving rain (EPSRC, 2003; SECCP, 2005). These risks have the potential to cause extensive damage to the physical structure of buildings, a loss of productivity and a reduction of businesses working hours due to staff health problems relating to poor conditions (EPSRC, 2003; SECCP, 2005).

In 2009 UKCIP contacted a number of SMEs in a report exploring vulnerabilities to flooding and other climate related events (UKCIP, 2009a). They found that over half had been affected by an extreme weather event between 2007 and 2009. The majority contacted agreed that adapting to

climate change would directly benefit them but only half of those previously affected had developed an action plan for future incidents (UKCIP, 2009a).

Research by AXA Insurance discovered that only 8% of businesses that had been flooded received a flood warning and 90% of SMEs were underinsured by substantial amounts against flood, risking heavy costs and increasing the likelihood of going out of businesses (Crichton, 2006). There is also a lack of awareness amongst SMEs on the time it takes to recover from flooding, with many underestimating the length of the recovery process (Crichton, 2006).

Stormwater and inefficient urban drainage systems could impact levels of flooding (EPSRC, 2003). Inefficient drainage systems also increase the risk of contaminated flood water, which is a serious risk to some businesses, such as restaurants, that are dependent on strict hygiene standards (EPSRC, 2003; UKCIP, 2009a).

Increases in rainfall also lead to a higher risk of slope instability and landslides, putting businesses on or below hills or slopes at danger (EPSRC, 2003). Damage to buildings and economic loss due to disruption of transport and utility services are potential side effects to landslides that would negatively impact businesses (EPSRC, 2003).

### Coastal erosion

A number of businesses are at risk from coastal erosion (EPSRC, 2003; SECCP, 2005; CBI, 2009). Increased sea levels and rainfall have the potential to accelerate the rate of coastal erosion in the South West, making many businesses located on the coast vulnerable.

### Subsidence

Particular locations are at risk from subsidence, such as those built on clay soils (EPSRC, 2003). Dry summers and changes in sea level may aggravate the ground on which foundations are built upon, putting businesses in particular locations at risk from severe structural damage (SECCP, 2005).

### Building infrastructure

The EPSRC (2003) points out that rising carbon dioxide levels in the atmosphere could lead to rainfall with increased acidity. Such acid rain damages the structural integrity of a number of common building materials, such as lime mortar and stone materials, and could cause costly damage to building infrastructure across the UK (EPSRC, 2003). It also suggests that other building materials such as plastics could be damaged due to increased ultra-violet radiation.

Increases in temperature are expected to have an effect on the thermal loading of buildings through both direct stresses and the influence of expansion and contraction cycles on building materials (EPSRC, 2003). Similarly, freeze-thaw cycles that could occur during periods of extreme cold weather events may significantly damage some structural materials. Timber frames – still widely used in construction – may be vulnerable to changes in humidity and, therefore, reduce the structural stability of certain buildings as climatic conditions change (EPSRC, 2003).

### Wind

Potential increases in wind speed and changes in wind patterns may require the design and development of more robust building rooftops (EPSRC, 2003). Prediction of future wind patterns from climate models is extremely difficult, meaning that uncertain trends and patterns may occur (EPSRC, 2003; SECCP, 2005, CBI, 2009). It is possible that uncertainty such as this may cause some SMEs to ignore potential effects as they cannot be accurately predicted.

### Heat

Future drier summers could lead to increased frequency and length of droughts across the UK (UKCP09, 2009). Outdoor leisure businesses may suffer from direct damage to facilities such as golf courses, while higher average summer temperatures may lead to a lower work rate of staff (EPSRC, 2003; SECCP, 2005). In 2007, a report by Donaldson and Keatinge (2007) calculated a 1 in 40 chance of the South West experiencing a severe heat wave (causing around 9,000 deaths) by the year 2012.

### Health & safety

An increase in extreme weather events and changes to the current climate could make staff health and safety a bigger issue for businesses, as the risk to human health increases (Sussman & Freed, 2008). Work attendance, work rate and staff hours for a business may all be negatively affected by climate change, while insurance and healthcare costs could rise if events become more frequent and severe (Sussman & freed, 2008).

### ***Indirect effects***

Many indirect negative effects relating to weather events in a changing climate have also been identified throughout the literature. Chegini (2005) notes the potential for indirect losses due to storms, which are expected to be more frequent, unpredictable and powerful across Europe and other parts of the

planet as global climate changes. Energy and telecommunications infrastructure is extremely vulnerable to extreme weather events (EPSRC, 2003).

### Energy

Extreme weather events already cause infrequent but significant disruption to the UK's electricity supply, but an increased frequency of extreme weather events related to climate change could exacerbate this further (EPSRC, 2001). The EPSRC says that the UK power system is vulnerable to unusual combinations of weather such as electrical storms and windstorms that are expected to increase in frequency and severity over the next few decades (UKCP09, 2009).

Severe gales have damaged electricity supplies in the past and increases in winter average wind speeds (and also extreme wind speeds) would make overhead transmission lines more susceptible to damage and failure (EPSRC, 2001).

Increased summer temperatures are expected to lead to a higher incidence of heat waves (UKCP09, 2009) and associated power outages across the national grid (EPSRC, 2003). This is attributed to the increase in demand from cooling appliances during such times (SECCP, 2005) and the heat damage to the physical infrastructure of the grid, especially overhead power transmission lines (EPSRC, 2003). Increased temperatures may also cause problems in urban areas where electricity sub-stations are unable to cool sufficiently overnight (CBI, 2009).

The risk to businesses from a more insecure power system could be very high, with blackouts potentially reducing the work hours of South West businesses where backup generators are not in place. A large number of UK power stations are located along the coastline (for example, the Hinckley Point station near Bridgwater) and could be susceptible to flooding if sea levels rise, potentially cutting power to businesses in the South West (EPSRC, 2003).

### Transport

Bad weather regularly causes delays, accidents, missed business opportunities and severe inconvenience to transport networks (EPSRC, 2003; CBI, 2009; SECCP, 2005). Additional factors are being brought in by climate change through the alteration of weather patterns and occurrence of extreme weather events that will exacerbate these problems (UKCP09, 2009; EPSRC, 2003).

Continuous rainfall and flooding has been shown to lead to earthwork instability on railways, requiring intensive maintenance and groundwork repair (EPSRC, 2003). Storms and coastal erosion in recent years have breached or damaged National Rail coastal defences in Dawlish, causing widespread disruption and financial damage (CBI, 2009; Environment Agency, 2010). The UK rail network is mostly built on low lying land and is therefore susceptible to widespread flooding, with greater risk if sea levels rise. Increased rainfall and flooding can also disrupt road travel, with reduced traffic flows and road closures in areas that have been particularly hard hit if drainage systems are inadequate (EPSRC, 2003). Certain businesses may be vulnerable to access restriction in flood locations.

Increases in sea levels may require road and rail networks to be re-routed if coastal defences cannot be installed or are insufficient. Maritime transport is also vulnerable; particularly in the South West where a number of ports, harbours and offshore installations may require modification depending on levels of sea level rise (EPSRC, 2003). Restrictions to maritime transport could provide a huge financial cost to businesses across the UK as they become unable to ship goods either to or from their sites.

Increased temperatures raise vulnerability to transport networks and, therefore, the supply of goods and services either to or from a business. Rail networks have critical temperature thresholds (EPSRC, 2003), whereby increased temperatures impose speed restrictions on the network and cause tracks to buckle. The EPSRC also points out that road and airport runway surfaces can be damaged by high surface temperatures, causing closures and delays. A higher frequency of very hot days could mean more speed restrictions, a higher incidence of rail, road and air delays and more frequent travel cancellations.

Extreme low temperatures can also cause problems to travel networks, with snow and ice causing speed restrictions, accidents and closures on roads and cancellations and delays to air and rail travel (EPSRC, 2003), as seen during the heavy snowfall in January 2010.

Reports have found that, despite its dependence on weather and past negative experiences, the transport sector does not have climate change adaptation high on its lists of priorities, with no coverage at board level risk reviews (Chegini, 2005; Metcalf *et al*, 2003). Damages to the UK transport sector could have a massive knock-on effect on the performance of businesses in the South West, thus increasing indirect vulnerability.

### Telecommunications

Telecommunication networks across the UK are a critical part of utility systems and are vulnerable to a number of extreme weather events, including lightning storms, strong winds and heavy rainfall (EPSRC, 2003; SECCP, 2005). An

increase in the frequency of extreme weather events as a result of climate change could lead to telecommunications blackouts occurring with more regularity. Disruptions to telecommunications systems could, therefore, affect many businesses, especially in the service sector and have a strong negative impact on the output of the South West regional economy, with businesses unable to operate at maximum capacity.

Prolonged loss of telecommunications has been shown throughout the literature to have a serious negative effect, particularly amongst smaller businesses which generally do not have back up plans and are more vulnerable to short term business interruptions (EPSRC, 2003; CII, 2009; UKCIP, 2009a; Environment Agency, 2010).

### Water resources

Climate change is expected to increase water demand while reducing supply, particularly in the summer, through an increase in cooling demands and a decrease in reservoir and river water levels (EPSRC, 2003; Metcalf *et al*, 2003; UKCP09, 2009). An increasing incidence of drier summers may cause water shortages with increasing frequency and severity. Better water strategies will be required by businesses to alleviate their reliance on mains water systems and increase their operational capacity during times of drought. The UKCP09 (2009) has projected that rainfall will decrease by a central estimate of -20% in the South West by the 2050s, which could lead to regional water shortages.

Over the past few years there have been a number of incidents where flooding has led to the disruption of water supply systems . For example, the floods in 2007 left 350,000 people in Gloucestershire without mains water after a water treatment facility was flooded (Environment Agency, 2010).

The impact of water shortages will vary depending on the nature and practice of a business but for those heavily dependent on consistent, reliable water supplies, such as in the agricultural sector, the impact could be costly and disruptive.

### Supply chains

Many organisations outsource a number of facilities and services to other companies and are dependent on complex and extended supply chains and networks. However, the use of business continuity management (BCM) further down the supply chain remains limited (Woodman & Kumar, 2009). A 2009 report by the Chartered Management Institute (CMI) discovered that only 10% of organisations surveyed used suppliers that all had BCM plans in place, while a third were not even aware (Woodman & Kumar, 2009). Further research shows that only 18% of companies who use suppliers with BCM plans actually verify the plans themselves. These figures display complacency amongst SMEs

to ensure that their supply chains are prepared for unexpected external circumstances such as extreme weather events, and increase the risk placed upon their optimal operation by such events.

It is essential to ensure that key suppliers have BCM arrangements in place. The British Standards aim to support BCM assurance throughout the supply chain, making it easier for SMEs to evaluate and reduce their vulnerability through supply chain disruption.

Across the literature there is agreement that changes in global climate could affect the availability of some goods and services such as raw materials and components, as well as affect parts of supply chains that are spread across the globe (Metcalf *et al*, 2003; UKCIP, 2009b; CII, 2009; CBI, 2009). A lower availability of such goods could increase commodity prices and make it harder for businesses to reliably obtain materials. While the impact of this may vary across different sectors, there is potential for operational disruption to many businesses.

The more complex and geographically spread a business' supply chain is, the more important it is to ensure they are adapted to be resilient to the potential effects of climate change. A major consequence of any failure in energy, transport and telecommunication systems is the knock-on effect on other areas of supply chains (CBI, 2009).

## **SMEs**

The Chartered Insurance Institute (CII) concludes in its 2009 Climate Change Research Report that SMEs are the most vulnerable type of business in the UK to climate change related impacts and that businesses in many sectors are not well prepared (CII, 2009). A report by AXA Insurance found that only 26% of SMEs saw climate change as a threat (AXA, 2006).

Risks to the operation of SMEs include; increased cost, slow or poor response, safety impacts, business operations under threat, shortened lifetimes of business stock and missed opportunities to gain competitive advantage.

Reports have found that the majority of SMEs are unaware of, or unconcerned with, the potential threats of climate change and are poorly prepared, despite the fact that they are, in general, more vulnerable to these impacts than larger businesses (UKCIP, 2009a; CII, 2009; Crichton, 2006). The CII report discovered that awareness of long-term risks and impacts is extremely low. This is possibly due to the short term planning of SMEs and that adaptation is not as well understood as mitigation. In Crichton's (2006) study, 71% of SMEs in high-risk flood areas were unconcerned with flooding or climate change, while only one in four of the SMEs saw climate change as a direct threat to their business. Most SMEs are also unaware that they can sign up for flood warnings from the Environment Agency (UKCIP, 2009a). A lack of awareness

and knowledge can lead to a lack of flexibility around business activities and increased vulnerability to climate change related impacts (SECCP, 2005; Crichton, 2006; UKCIP, 2009a; UKCIP, 2009b).

Many of the SMEs surveyed by Crichton (2006) were unaware of the potential costs of underinsurance. Crichton also found that 1 in 3 SMEs did not have business interruption cover and were, therefore, at great risk of collapsing or losing employees in the event of significant disturbance.

The UKCIP (2009a) have cited research into the cost-benefits of flood resistance and resilience measures, which found that temporary resistance measures can reduce damage costs by around 50% - yet many SMEs at risk are not establishing them. The CII (2009) states that, while there are opportunities for mitigation to climate change, SMEs need to adapt quickly to protect against the threats.

SMEs have a need to make contingency plans to safeguard against loss and alleviate the impacts of severe weather events. There is evidence that there is a lack of BCM amongst SMEs (Crichton, 2006; UKCIP, 2009a). This can be put down to a number of reasons such as; cost or time constraints, a business believing it is already prepared and will survive any interruption, that a crisis is not on the near horizon, or that the potential problems are too small to matter or too large to deal with (Crichton, 2006; UKCIP, 2009a). This evidence displays a severe lack of knowledge amongst SME decision makers relating to the potential effects of a changing climate, and increases the risk of avoidable damage occurring in an extreme weather event through lack of preparation.

The CMI found that, in 2008, only a quarter of small organisations had business continuity plans, despite the widespread flooding the year before (Woodman & Kumar, 2009). There is also evidence that BCM has become a lower priority amongst private businesses since the economic downturn (Woodman & Kumar, 2009). The CMI report also discovered that only a fifth of all organisations covered supply chain disruptions in their BCM plans. It is important to note that the awareness of risk is not necessarily followed up with the adoption of BCM measures to mitigate these risks amongst SMEs.

There is also evidence that climate change is not a priority for many businesses, as short term drivers dominate business thinking and long term socio-economic trends are believed to pose a greater threat to businesses than climate change (Chegini, 2005; CII, 2009). The long term nature of climate change does not suit the short planning horizons of SMEs, which results in climate risks being put aside. Crichton (2006) suggests that adaptation responses need to bring other more tangible and short term benefits if they are to be taken up by SMEs.

Weather and climate are perceived by some to be a stationary and certain environment and, therefore, predictable and avoidable, with some SMEs concentrating not on adaptation to climate change but instead relying on

improved weather forecasting (Chegini, 2005). By adapting to current weather risks there will be a benefit to business adaptation both in the short term and in the long term when extreme weather events are likely to be more frequent and severe.

There is evidence that SME leaders and businesses with a creative, dynamic culture are more likely to be engaged in climate change messages that emphasise the opportunities from climate change, as well as the risks (Chegini, 2005). The entrepreneurial nature of SMEs means they may be more favourable to a focus on positive outcomes, where possible adaptive methods may give them a competitive edge over other businesses. If benefits are more certain SMEs may be more willing to spend time and money on preparation, even if the magnitude of events is smaller (Chegini, 2005).

Supply chains may operate on local, national and global levels and will, therefore, be more susceptible to widespread disruption from multiple sources. It is important that SMEs understand their level of vulnerability through supply chains and utilities, and have business continuity plans in place to ensure that essential services will operate efficiently in severe weather events.

It is also important that resilience and adaptation to climate change is integrated with core SME business management concerns, rather than just being treated as a non-serious environmental management issue. The confusion commonly held between mitigation of the causes of climate change and adaptation to its effects provides risks for the vulnerability of SMEs (Chegini, 2005). Adaptation, therefore, should instead be integrated with similar business areas such as business continuity planning and risk management (UKCIP, 2009b). There is a risk that an increase in extreme weather events could cause businesses to require costly and disruptive design or location changes to continue their operations (Sussman & Freed, 2008).

There are some acknowledged advantages to the effects of severe weather events and climate change (Chegini, 2005; UKCIP, 2009b, CBI, 2009) but these are almost exclusively individual competitive advantages where businesses have taken appropriate adaptive measures.

Levels of vulnerability will vary among businesses, depending on the nature of the impacts. For example, the agricultural sector is especially vulnerable to direct changes in climate (Chegini, 2005). The wet weather in the summer of 2004 did more financial damage to the UK agricultural sector than the foot-and-mouth crisis, while the 1995 climate anomalies caused a net loss of £180 million (Chegini, 2005). The food and drink sector may be affected by long term weather trends, as differences in climate could lead to reduced reliability of certain produce, as well as increased risks to water supply and access to land (Sussman & Freed, 2008). There is also an increased risk of infection to livestock and wildlife and plant disease. Transportation infrastructure may also be disrupted due to flooding, while the restricted availability of water could

cause problems throughout the production and manufacturing process (Sussman & Freed, 2008).

The construction sector is vulnerable to extreme weather events through a number of direct and indirect ways. Such events may affect site work (such as muddy site conditions), disrupt transport for site deliveries and damage key infrastructure (such as drainage) (Sussman & Freed, 2008). Sussman & Freed also point out that certain construction processes may be negatively affected by extreme summer temperatures, while design standards may need to be upgraded as the climate changes.

## ***Conclusions***

It is clear from the literature reviewed that extreme weather events occurring in the current climate can and do have severe impacts on businesses, with SMEs being by far the most vulnerable business type in the UK; a particular concern for the South West region. As climate continues to change and severe weather events become more frequent and powerful, the risk to SMEs is expected to become greater. The nature of vulnerability to SMEs is dependant on many factors, including; business location and type, dependence on supply chains and utilities, preparation for direct and indirect disruptions, knowledge and awareness of climate risks, and insurance coverage.

Across SMEs there is a lack of knowledge and awareness of the potential impacts of climate change, with many SME managers and decision-makers not realising how vulnerable their businesses are, or what measures can be taken to avoid or limit damage. There is a clear need to communicate the direct and indirect risks of climate change to SMEs and outline the difference between mitigation and adaptation.

As the literature has suggested, potential direct consequences are often exacerbated by a lack of accurate business planning or underinsurance. SMEs are less likely to have structured decision-making processes than larger companies and have fewer resources available to respond to impacts. This makes it less likely that they will be adequately prepared for long-term climate change and increasing their vulnerability.

The short term nature of SMEs, together with the uncertainty inherent in climate change, provides a barrier to adaptation, with many decision makers not including climate change mitigation or adaptation in their plans. SMEs are also more vulnerable to short term interruptions than larger businesses due to their lower resource capacity and subsequent ability to absorb short term losses.

While climate related risks are not at the top of businesses' priority issues, it is entirely possible that they could affect the issues that are its top priorities, such as finance, markets, logistics and premises, through indirect impacts.

Any disruption to utility services and supply chains will have negative consequences to businesses in the South West that are not adequately prepared. Loss of power, water shortages and transport restrictions could cause massive disruption to SME operations and cost huge sums of money to the regional economy, while supply chain disruptions may hinder or halt business activity. Indirect impacts are more variable between businesses than direct impacts, as each company has its own set of supply chains with different levels of reliance on each.

There is a need for further research into the awareness of climate change and extreme weather events, and associated vulnerability between different business types and sectors. It is generally acknowledged that awareness to climate change is low and that risk is often under-perceived. However, the reasons for this lack of awareness and adaptation, and how it is affected by business type, is not fully understood. There is also a need for further research into the dependence of particular sectors to utility service and supply chain disruptions and how vulnerability to such disruptions is affected by business type.

There are a number of key messages from the literature to take forward to assist businesses in the South West in reducing their vulnerability to climate change related events. These messages are:

- Engagement with key stakeholders is vital in communicating information to SMEs
- Emphasise opportunities, as well as risks arising from climate change to SME leaders and decision makers, targeting areas of benefit
- Emphasise the risks of climate change
- Focus on resilience to current weather
- Ensure supply chain reliance through self monitoring
- Adaptation considerations need to be embedded into established risk management and decision procedures
- Sector and business specific tools and guidance are necessary to match business needs

A number of initial findings from the literature review lay the foundations of the project to explore further, in order to answer questions one to three of the project brief. These findings can be summarised briefly as:

- SMEs are the most vulnerable type of business, with the smallest being especially at risk
- Vulnerability to direct impacts is dependant on geographic locations and business operations
- Indirect impacts, however, have varying levels of influence across different business sectors and depend on the level of a business' reliance on national or global supply chains

- Disruption to utilities (particularly power) is a risk to the operation of South West businesses
- Understanding and awareness of climate change risks is extremely low, with SME planning commonly insufficient due to knowledge gaps
- The nature of vulnerability to businesses is dependant on their operations and the contingency plans in place
- Vulnerability is being addressed differently between businesses, but responses to risks are generally slow and uncoordinated even across the same sectors

## 7. Findings

A number of vulnerabilities to climate change were identified in the literature review and interviews. These vulnerabilities related to the impacts of three extreme weather events (flooding, water shortages, and high temperatures), five service disruptions (power, water, telecommunications, road, and rail), and the complexity and vulnerability of supply chains.

### 7.1. Extreme weather events

A significant number of possible impacts arising from the three weather events examined were common across the four key sectors as set out below

- Flooding
  - Loss of business stock
  - Rises in insurance costs
  - Obstruction of site access
  - Equipment failure or damage
  - Obstruction of key transport routes
- Water shortages
  - Impact on non-essential systems such as toilets
  - Disruption to equipment/machinery requiring large volumes of water for cooling such as air conditioning
  - Limited access to water due to droughts
- High temperatures
  - Reductions in staff work output
  - Staff health and safety impacts
  - Damage to IT systems
  - Increased costs on air conditioning
  - Damage to electricity generation and transmission systems

An overview of the level of risk to each key sector from the extreme weather events examined is shown in table 2. These ratings were based on identifications of vulnerability in the literature and responses from interviews.

Sector	Flooding	Water shortages	High temperatures
Advanced engineering	high	medium	low
Transport & distribution	medium	medium	low
Food & drink manufacturing	medium	high	Medium
Construction	high	low	low

Table 2: Level of risk of impacts across key sectors

## **7.2. Service disruptions**

Service disruptions had a wide range of possible impacts across the four key sectors, depending on scale, length and severity. Impacts that were common across the four key sectors from service disruptions included the following

- Power
  - Disruption to machinery
  - Disruption to IT systems
  - Disruption to telecommunication systems
  - Failure of backup generators where disruption is prolonged
  - Stock damage where continuous power is necessary (i.e. refrigeration)
- Water
  - Impact on non-essential systems such as toilets
  - Disruption to equipment/machinery requiring large volumes of water for cooling such as air conditioning
- Telecommunications
  - Delay of product imports and exports
  - Disruption to logistics and distribution
  - Disruption to business network where dedicated lines are not in place
- Road
  - Delays to product imports and exports
  - Disruptions to staff/site access
  - Delays to production due to lack of space
  - Loss of short-lifespan products
- Rail
  - Delays to product imports and exports
  - Disruptions to staff/site access
  - Delays to production due to lack of space
  - Loss of short-lifespan products

Table 3 displays the overall vulnerability of each of the four key sectors to service disruptions, using a scoring scale from one (not vulnerable) to five (extremely vulnerable). These ratings were based on identifications of vulnerability in the literature and responses from interviews.

	Power	Water	Telecoms	Road	Rail
Advanced engineering	high	low	medium	high	medium
Transport & distribution	low	low	high	high	medium
Food & drink manufacturing	high	high	medium	high	low
Construction	low	medium	medium	high	low

Table 3: Key sector vulnerability to service disruptions

### 7.3. Supply chains

The complexity of supply chains varied between sectors but in general was towards the high end of the scale. Supply chain vulnerability was viewed as less complex across all sectors except food and drink manufacturing.

Table 4 gives an overview of the complexity and vulnerability of key sector supply chains using a scoring scale from one (low complexity/vulnerability) to five (high complexity/vulnerability). These ratings were based on identifications of vulnerability in the literature and responses from interviews.

	Supply chain complexity	Supply chain vulnerability
Advanced engineering	5	4
Transport & distribution	3	3
Food & drink manufacturing	3	4
Construction	5	3

Table 4: Supply chain complexity and vulnerability

Levels of supply chain vulnerability varied slightly from complexity because of a number of factors. These factors, such as dual sourcing, supplier reliability, commonality of product and reliance on product can determine how vulnerable a supply chain is regardless of its complexity. In general, the higher the complexity of chains the more vulnerable they are but there were instances in the construction sector of highly complex and international supply chains in use for common products whose suppliers could be changed swiftly, and examples in the food and drink manufacturing sector of short supply chains that were difficult to dual source and vital for business operations. Table 4 demonstrates that while the vulnerability of supply chains is influenced by complexity, there are many underlying factors that help to determine the nature and level of this vulnerability.

## **7.4. Advanced engineering**

### **Sector Overview**

Interviews were conducted with an Aerospace Technology Project Manager from the South West Regional Development Agency and an EEF Head of External Affairs.

The size of advanced engineering businesses varies with an average number of employees 'considerably less' than 100 although some companies such as Airbus can employ up to 1,000. Extreme weather risks are considered by a growing number of companies in the sector from an operations point of view. However, while the majority of companies are aware of and appreciate the risks, only a minority (generally the large companies that have strong resources and experience) translate this into planning. This is due mainly to short term financial considerations and the current focus of businesses on survival, with many businesses unable to direct resources at longer term issues (even 5 year plans are greater than current planning horizons for many businesses). Of the companies that are considering extreme weather and climate change in their business plans, it is experience of problems that dictates inclusion in business planning procedures. Many are including extreme weather in a response to problems that they have suffered, rather than planning for it in advance. Examples of inclusion in future planning include companies that have taken measures to avoid flooding by diverting water away from sites and catchment areas by digging out new streams. However, not all of those that have been hit by extreme weather events in the past, such as the Gloucestershire floods, have subsequently included it in their planning.

Throughout the sector there are very few opportunities perceived by businesses as a result of extreme weather and climate change. Opportunities depend on the line of work that businesses are in and are limited, for instance, to companies manufacturing weather resistant products or renewable energy technologies, as new markets are created as a response to climate change and future engineering demands. There is little opportunity as a direct result of climate change but one interviewee admitted that it is 'possible to conceive of product lines in the future'. Potential opportunities may arise as markets change, as global investment is creating new areas for companies. However, this is largely dependent on external markets.

### **Vulnerability from extreme weather**

Throughout the interviews, flooding was identified as the highest risk to advanced engineering companies due to the high direct costs of damage that would occur to business stock and the losses attributed to lack of site access. Vulnerability to flooding varies between companies based upon geographical location and susceptibility of particular areas to flooding. The 2007 Gloucestershire floods caused considerable stock damage (including rust, destruction and equipment failure) to a number of engineering businesses and affected further companies through access problems. The vulnerability of advanced engineering businesses to water shortages depends on the type of business; while many do not use much water, others are heavily dependent on

it for machinery and cooling. Water shortages also pose a problem to businesses as it is required for air conditioning. High temperatures can cause problems with staff output levels and some machinery but is generally a low-level concern.

### **Vulnerability to service disruption**

Power, telecommunication and road transport disruptions were identified as the most unsettling service disruptions to the advanced engineering sector. Power disruptions have the potential to cause widespread costly delays to production if they persist for a considerable amount of time. Diesel generators are in place to provide backup power in the event of disruptions but these can only offer a short-term solution, as they are unable to power for long.

Vulnerability to water disruptions across the sector is largely dependent on the type of product that businesses are manufacturing. Overall the risk to disruption is low, as the majority do not have high water requirements for production.

Telecommunication disruptions present a relatively high level of risk to advanced engineering businesses as continued interruption to dedicated lines can cause organisational and logistical chaos, leading to projects being put on hold, delivery of key data files being delayed and workloads overlapping. Telecommunication disruptions also have a large knock on effect on transport in the sector, as the shipment of products is kept to a very tight schedule, which must remain prompt.

Delays to transport can affect subsequent work if warehouse space is not available as a result - one example given by an interviewee was an aerospace manufacturer unable to continue production until large aeroplane parts were transported. There is also transport risk due to the high volumes of components that are transported amongst the sector, meaning that short term disruptions of 3 days can have very big secondary impacts. Of transport networks, disruptions to road networks carry a higher level of risk than those to rail networks. This is due firstly to the large proportion of products that are moved on roads (only some are dependent on rail transport) and secondly to the relatively easy transition of rail goods to roads.

There is uncertainty across the sector as to how well businesses have adapted to service disruptions, if at all. Businesses are expected to have contingency plans in place to deal with disruptions, including extreme weather events, but levels of vulnerability are viewed as high. ISO standards dictate that disaster recovery plans must be tested twice per year but there are concerns over this as it does not provide a 'real world' scenario.

### **Vulnerability to supply chains**

Supply chains in the advanced engineering sector are extremely complex and often include a large number of suppliers. A small number of businesses use short supply chains but the vast majority are dependent on continental and

global chains. Overseas sourcing to the UK has increased in the last decade with many components now sourced pan-globally. This prevalent international dimension makes supply chains across the sector exposed to a wide range of global issues, disruptions and risks.

Overall there is a low likelihood of supply chain problems occurring to businesses due to the supply planning that takes place across the sector. This includes the dual-sourcing of components where possible and the system of having approved backup suppliers to cover in the event of supply chain disruption. Switching to new suppliers, however, can have disruptions to businesses in the order of months. Despite these backup suppliers there is still vulnerability to certain high-tech products that can only be single-sourced as they are produced by a single company in a single location, meaning that disruption to such a supplier can cause chaotic delays across the sector. In the case of single-sourced components there is a high level of risk inherent that is shared by a number of businesses. This 'risk sharing' is a key vulnerability of the sector as a whole. There is also vulnerability to short term disruptions due to the large number of parts that are supplied from different locations; a delay to just one supplier can cause an entire product line or project to be put on hold while components are sourced from an alternative supplier. Overall vulnerabilities to supply chains in the advanced engineering sector are low likelihood but high impact and, therefore, vulnerable.

Some organisational help is given to advanced engineering businesses in developing their IT to encourage them to stay in the South West, but there is little assistance in helping businesses to acknowledge and prepare for the impacts of climate change or the risks that they are facing. This is a common theme across business sectors and not specific to the advanced engineering sector, as highlighted in the literature review.

## ***7.5. Transport and distribution***

### **Sector Overview**

Interviews were conducted with a National Rail Route Planner, Highways Agency Regional Manager and a Highways Agency Director.

Within the road transport and distribution sector, 85% of businesses employ less than 6 people running an average fleet size of 3.7 vehicles. Across the rail network employee numbers are much higher due to the limited operations of National Rail and a small number of large passenger and freight companies. There is not much accommodation in business planning for risks from extreme weather and climate change and there appears to be a general lack of preparedness across the sector, even after major events such as the January snowfall. Extreme weather is viewed as an unavoidable fact of life so there is an attitude of reducing operations and behaving accordingly, with many businesses not taking action as events are so infrequent. Most businesses in the road transport and distribution sector are concerned about current economic implications and are concentrating on short-term forecasts rather

than long term implications, with rising fuel prices and increased continental competition putting further economic strain on business operations (particularly smaller companies who do not have economies of scale).

Businesses that operate internationally have a higher level of risk inherent to their operations from extreme weather and climate change as they have a larger geographical area to consider when planning. On the rail side of the transport and distribution sector, weather issues are seriously taken into account by businesses. Many have contingency plans in place to deal with disruptions, as they are viewed as serious with limited alternative routes in many places. However, rail businesses are reliant on National Rail to maintain the network and, therefore, have little control over the immediate network responses to problems. Risk assessments by National Rail ensure that service is deliverable as quickly as possible after a major event and contingency plans are immediately implemented. Adaptation operations such as sea wall construction and cliff face netting also reduce the risk to vulnerable areas of the network, such as coastal or low-lying areas.

Across the sector very few opportunities are seen to be available from extreme weather and climate change. These limited opportunities include more work for rock salt companies during heavy snowfall and increased cooperation between businesses and authorities. These opportunities, however, are vastly outweighed by the sharp reduction of work that occurs during disruptive events.

### **Vulnerability from extreme weather**

Flooding was identified as the highest risk event to road transport businesses. Affects of flooding are wide ranging and include damage to head offices, obstruction of routes and damage to fleet. There are concerns across the sector of the climate change prognosis for increased flooding, as this can be highly disruptive. This was demonstrated in the Gloucestershire floods when businesses in Tewkesbury were cut off for days and the M5 motorway was disrupted by floods. Obstruction to key areas of the road network, such as motorways, can cause widespread chaos and affect thousands of businesses through limited transport access.

Water shortages have a small affect on road transport companies, generally only being necessary for non-essential services at offices such as toilets. High temperatures similarly have a limited affect as the extreme temperatures required to damage the road network are extremely infrequent.

Obstructions to key infrastructure in the road network can have a significant impact on businesses even where detours are available due to fuel prices and consumption and the fact that drivers are legally limited to the distance they can travel during set periods. A 35 mile detour around an obstruction effectively reduces a drivers weekly distance by 70 miles and, if operations have been planned with little margin for manoeuvre, distribution may therefore be disrupted leading to lost business. There have also been problems

with low temperatures, such as past closure of the Severn bridges due to dangerous ice formation on overhangs and a lack of salting access on some roads.

Rail networks are considerably vulnerable to flooding, water shortages and high temperatures. Coastal and low-lying areas of the network are vulnerable to flooding despite a number of adaptation methods that have been taken - including track drainage and flood defences such as the sea wall in Dawlish. The lack of routes in the South West means that interruption to just a small section of track can have impacts that effect business across the region. Water shortages can lead to track instability as dried land puts stress onto tracks and can cause damage.

High temperatures similarly have a risk of damaging rail network infrastructure, particularly by causing malfunctions with signalling technology and direct damage and buckling to tracks in cases of extreme heat. Modern technology and modern techniques are helping to increase the resilience of the rail network to extreme weather events but an increase in the frequency and severity of events could cause further disruption to the network.

The distribution of effects across the sector is relatively even. While the location of head offices will determine their vulnerability to direct flooding, all transport and distribution businesses can be affected by flooding if it disrupts a key area of the transport network. Businesses that operate with just-in-time deliveries are particularly vulnerable to disruptions as they have little room for flexibility, with the potential for a service interruption in one place to have a major knock-on effect. Smaller businesses can be more vulnerable than large operators, as they may be confined to operations in a particular area. This means that an extreme weather event disruption could cease their entire operations, while it would only provide a 'pocket' of disturbance to a large operator.

Disruptions to the rail network tend to affect freight companies more than passenger companies, as the transition of goods from rail to road is more difficult than that of passengers. Freight companies also may not have the same financial security as passenger companies and disruptions may lead to a perceived lack of reliability and loss of business. The road transport side is resilient to certain events, such as flooding where lorries can travel through much deeper water than other vehicles and continue operating if flood levels are relatively low. If, however, flooding is centred on delivery points, a reduction in work is inevitable due to the lack of site staff to unload deliveries; 98% of the journey may be viable but the last section is blocked.

### **Vulnerability to service disruption**

Service disruptions to the sector vary between road and rail businesses. The main problems caused by disruption to power supply are the effect it has on IT and telecommunication services. Most businesses in the sector can run for a short period on limited power but long term disruptions would lead to a

reduction in service provided. Rail businesses are more vulnerable to power disruptions as the backup generators in place cannot power systems indefinitely. Water shortages pose little risk to both sections of the sector, only providing disruptions to non-essential areas such as toilets. Businesses across the sector are highly vulnerable to telecommunication disruptions due to the heavy reliance on regular updates to operations and the problems that this could cause with route management. Rail networks have backup systems in place but the initial disruption would be damaging and the backups may not last long.

Road transport and distribution businesses are extremely vulnerable to disruptions to the road network, as their operation is entirely dependent on them. As stated above, detours can be time consuming and costly when available and in the case of disruption to vital areas of the road network (such as access to depots), operations may cease entirely. Disruptions to road networks can also pose risk to rail businesses where the disruptions occur at road/rail junctions, bridges, freight depots or passenger terminals. Road access is also vital for rail maintenance so vulnerabilities can be exposed if certain areas of the road network are damaged.

Disruption to the rail network has little negative effect on road transport businesses as the majority (90%) of movement in the UK is already taken by road. In some cases rail disruption may have a positive effect on road transport and distribution businesses as they may gain extra work to cover the disruption of rail. Rail businesses are extremely vulnerable to rail network disruptions. While contingency plans may be in operation a reduced level of service is inevitable and costs can increase rapidly. The impact of disruptions varies depending on the location, time and size of disruption.

In the majority of situations where road businesses have been hit by service disruptions, little action has been taken to change business practices and increase resilience. This has either been due to financial restrictions or a lack of consideration that disruptions will occur again. In the rail network this is difficult as the network cannot be easily adapted or moved if there are problems.

### **Vulnerability to supply chains**

The complexity and length of supply chains in the transport and distribution sector is dependent on the type of business. Businesses that distribute products that have come from a long chain have more supply chain complexity inherent than those that transport local or national products. Both road and rail businesses are dependent on the functioning of a small number of key ports to import goods to the UK for internal distribution, but the supply chains involved in rail passenger transport and freight distribution are usually less complex than those of road businesses. The vulnerability of supply chains is dependent on their size and complexity but is generally quite high due to the wide ranging areas that problems can occur in. Disruption to a port, for instance, could have a major negative knock-on effect to transport and

distribution businesses as the goods for their distribution are not available. Vulnerability to road network supply chains is considered to be higher than that to rail network chains.

There is some work being done by sector organisations to help businesses through improving transport networks. For example, a recent survey of vulnerability by the Highways Agency looked at revising areas of low or damaged capacity to increase network reliability and performance as part of a project to increase flood resilience (Highways Agency, 2010).

## ***7.6. Food and drink manufacturing***

### **Sector Overview**

Interviews were conducted with a Food and Drink sector advisor of the South West Regional Development Agency, a partnership specialist from the South West Manufacturing Advisory service and a South West Food and Drink Executive Director.

Around 85% of food and drink manufacturing businesses in the South West are SMEs, with an even spread of employee numbers across businesses ranging from one or two to hundreds. In general the risks from extreme weather and climate change do not get mainstream consideration from businesses, and only tend to be prevalent in larger companies' business planning. Exceptions to this are a small number of forward thinking businesses or those who can see an opportunity through climate change or extreme weather events. Generally, smaller companies need 'hand-holding' through the process of including such risks in their business planning as the majority do not consider it as a valuable or worthwhile inclusion.

There is a growing trend whereby companies are improving their mitigation activities by introducing intelligent distribution, local sourcing of products, reduced fuel use and emissions and lowering their carbon footprints (generally only the larger companies take a wide look at their carbon footprints). Sector representatives who were interviewed on this issue conceded that these mitigation improvements were not necessarily for environmental reasons but due to more unstable economical conditions and the need to cut costs. The exception to this being reduced carbon footprints, which are part of mandatory Carbon Reduction Commitment Government regulations.

One of the problems encountered by small food and drink manufacturing businesses is that they tend to work on a week by week basis and therefore are extremely vulnerable to even short term events or disruptions. There is a lot more space for adaptation across the sector than is currently being done with climate change a very low priority for the majority of businesses. The knock on effect from disruption to primary producer is not fully understood or prepared for, as there have only been a limited number of issues to date - and even these are infrequently linked to climate change.

Throughout the food and drink manufacturing sector there are a limited number of perceived potential opportunities from climate change, such as the development over the last decade of the British wine industry as temperatures have increased. A number of farmers in the South West are now planting vines to make the most of the changing climate as a matter of economic priority. In general the sector is viewed as an innovative industry that reacts and adapts quickly to changing products and maximise opportunities out of economic self interest. These limited opportunities, however, are seen to be outweighed by the potential negative effects of climate change and the damages of extreme weather events. While the climate is now suitable for vines it is becoming unsuitable for other crops. A recent survey conducted by South West Manufacturing Advisory Service on the opportunities arising from low-carbon markets found that 90% of businesses saw no opportunity, and that the likelihood of opportunities from climate change would therefore be similarly low.

### **Vulnerability from extreme weather**

Interviews with representatives concluded that the food and drink manufacturing sector is considerably vulnerable to flooding, water shortages and high temperatures, which are amplified by the short cycle of food and drink. While only having a limited direct effect on manufacturing and processing, businesses' water shortages can cause severe to disruption to the growth of food products, which in turn has a damaging knock on effect.

Flooding has the potential to cause damage to business stock in geographically vulnerable locations, as the recent example of the Gloucestershire floods demonstrated where a number of businesses were damaged or experienced operation disruptions (Environment Agency, 2010).

High temperatures have led to heat problems with IT infrastructure causing system disruptions and damage and increasing the need for expensive cooling systems, with a number of businesses experiencing problems in the summer of 2009. High temperatures can also cause problems on the growing side, which have similar knock on effects to those of water shortages and flooding.

Due to the dependence of the sector on seasons, extreme low temperatures that persist for a considerable amount of time like those seen in January 2010 cause a number of problems for the entire sector, as primary products are delayed, damaged or killed. These knock-on effects show the indirect vulnerability that exists in the food and drink manufacturing sector to extreme weather events.

The effect that extreme weather events have on businesses in the food and drink manufacturing sector varies. The effects of flooding depend entirely on the geographical location of a business, not its size or type. High temperatures have the potential to cause disruption to all businesses where IT cooling is inadequate, with smaller companies at a marginally higher risk, as they do not have the same resource power to invest in cooling systems. The extent of

problems caused by water shortages is determined by business type; manufacturing businesses that require water for food processing and producers are the most vulnerable.

### **Vulnerability to service disruption**

The vulnerability of the food and drink manufacturing sector to service disruptions is considerable. Power disruptions can have a significant disruptive effect on processing and manufacturing businesses whose products are dependent on electronic machinery that requires a continual source of electricity. While a number of such businesses have backup power systems available, these may only provide temporary cover. Disruptions to water supply affect all stages of food and drink manufacturing - from producer to processor regardless of size. This is because many either require the input of water into products or are reliant on primary producers that are significantly dependent on water for product growth. Disruptions to telecommunications services do not carry the same level of risk as power and water disruptions, as production can continue without their operation. While not affecting vital operations, a breakdown in telecommunications can cause knock on problems and delays to logistics and distribution for businesses.

Disruptions to road transport are considered to be extremely high risk to the sector, as a number of food and drink products need to be shipped when ready. For example, a 5 day disruption can be devastating to a business that deals with fresh food products, as they need to reach consumers as soon as possible to ensure quality and freshness. Disruptions to the rail network are considered to have only a moderate effect on the sector, due to a lack of rail network coverage in the South West, the lack of goods that are transported by rail and the ease of transition of goods onto the road network. The food and drink manufacturing sector can be considered more vulnerable to short term disruptions than the other key sectors due to the short life cycle of the products involved.

Only a very small minority of businesses that have experienced service disruptions have adapted to increase their resilience should disruptions occur again. This is seen as largely due to a lack of awareness and a lack of prioritisation. Short term economic issues and drivers are seen as a much higher priority to many businesses than potential long term problems. Many companies are still in survival mode from the economic downturn and as a result of that are only looking to the next month of business and not considering future long term impacts. Preparation for future impacts is currently inadequate as knee-jerk reactions will not be enough to avoid problems. Many smaller businesses are operating on a bread line and do not have the resources to put adaptation plans into place.

### **Vulnerability to supply chains**

The complexity of supply chains in the food and drink manufacturing sector varies a lot from business to business. There is a growing culture in the South West to source products locally, whether that is due to economic savings or an

ethical consumer-driven move. In general, supply chains are not large or complex, particularly amongst the smaller businesses, although this can vary depending on business type and the product that is being produced. One interviewee suggested that across the sector the vulnerability of supply chains is dependent on their complexity and length, but in general those of smaller businesses tend to be more secure, as they contain less links and are based on a more local geographical area than the chains of larger companies. One of the most significant vulnerabilities with the supply chains is the number of broken linkages that exist where the chains do not operate as well as they could. Problems also occur in the supply chains where a supplier cannot produce or transport enough of a product to a business. Despite the resilience of certain supply chains in the sector there is generally a high vulnerability due to short food cycles; small problems can escalate very quickly and supply chain issues at primary source can have huge knock on problems for the rest of the sector as has been demonstrated by past crop failures and livestock diseases.

It was suggested by interviewees that lessons are learnt from Europe, particularly southern Spain where high temperatures have caused a number of problems. By examining these problems and using European connections it may be possible to adapt to potential extreme weather events and climate change in advance, instead of waiting for the effects to hit the UK and then learning or reacting.

There is help available from a number of sector organisations, such as the Environment Agency helping farmers with runoff problems. The main problem however is a lack of awareness of both what the problems are and the help that is available. In the majority of cases businesses – particularly smaller ones – are unaware of an issue unless it has directly or indirectly affected them and consequently are unlikely to address potential impacts until they hit them. In other cases where the risks are known they are not addressed but dismissed as unimportant or unlikely to occur.

## **7.7. Construction**

### **Sector Overview**

Interviews were conducted with a manager of sustainable construction at the South West Regional Development Agency and a member of Cornwall Development Company's Strategic Investment Framework team.

Most construction businesses in the South West are relatively small with 90% of subcontractors being SMEs. In general the risks from extreme weather and climate change are not included in most companies business planning procedures or operations. This is attributed to the recent economic downturn that has seen a large number of construction companies ceasing business due to financial restrictions. A number of construction companies have become more environmentally aware over the last few years but only a small minority are considering long term climate change impacts. This environmental

movement, whereby construction businesses are 'going green', is believed across the sector to be a financially orientated attempt to win more contracts rather than being born out of environmental values and concerns. There are problems with the inclusion of extreme weather risk in business plans for some construction businesses, as site locations are not permanent but change frequently when jobs finish. Steps are taken to protect against such events but due to the short term nature of work it is sometimes viewed as a non-essential cost.

There are very few opportunities expected to rise from extreme weather and climate change across the construction sector. There are a number of advantages to businesses that have strong green credentials; those that have environmental qualifications stand a stronger chance of more contracts than those without. These advantages, however, are not a direct result of either extreme weather or climate change but a by-product of increasing environmental standards and attitudes towards construction.

#### **Vulnerability from extreme weather**

Sector representatives identified flooding and heavy rainfall as being the highest risk extreme weather event to construction businesses. The vulnerability of businesses to flooding and heavy rainfall, however, depends on site location, size and the type of operations that they run. For example businesses that specialise in groundworks are vulnerable as groundwork is difficult in heavy-wet conditions, whereas mechanical and engineering businesses move onto site at a late stage when construction is almost complete. Large main contractors are vulnerable to flooding and heavy rainfall as they are responsible for the whole construction tender and, therefore, any vulnerability that sub-contractors have are shared by the main contractor. High temperatures and water shortages pose little threat to most construction businesses as they are manageable and have not been particularly disruptive in past cases. Extreme weather events are considered to be extraordinary events and as a result do not feature in many construction businesses risk or business plans. This is believed to be a problem in general with business attitudes to climate change, whereby allowances are not made for what are considered to be 'freak' occurrences.

#### **Vulnerability to service disruption**

The vulnerability of construction businesses to service disruptions is generally not as high as the other key sectors examined. Disruptions to power supply carry a relatively low level of risk as most construction sites are powered by on-site generators and many phases of construction do not require a dedicated source of electricity. One of the most significant issues resulting from a loss of power is the knock-on effect on telecommunications networks. Disruptions to water supply also have a relatively low impact on the construction sector as a whole, as most businesses and stages of construction (with the exception of concrete/cement mixing) do not require considerable amounts of water to continue operations.

Vulnerability to telecommunications disruptions is dependent on the length of disruption; short term (one week or less) disruptions are manageable as site offices are set up for the full construction period and hold all plans on location so can work independently. However, longer disruptions can cause problems with organising site deliveries or managing changing workloads arising from disruptions or delays. Disruptions to telecommunications networks also affect the operational ability of construction business head offices and, therefore, place another element of vulnerability onto construction companies.

Disruptions to transport networks – specifically road – are the most troubling of service disruptions. Deliveries of components and machinery are kept to very tight schedules meaning that a lack of access to site or disruptions on the road network can delay construction. Generally speaking rail networks are not used to transport a large amount of materials and in the event of disruption most loads can be transferred to road. Sector representatives admitted that a higher proportion of goods being transported by rail could benefit certain sites but in practice rail networks are not overly useful, as all loads have to be transported to stations and moved by road for the final leg of the journey anyway.

The UK construction industry is, on the whole, considered to be a reliable and robust network. Due to the short term nature of construction tenders the costs of preparation for adaptation in site locations is seen to outweigh the probability of event occurrence. There are sometimes difficulties in avoiding service disruptions due to the remoteness of certain construction operations and the limited control that they have over the reliability of external systems such as road network access to sites in remote locations. The snowfall in January 2010 caused financial difficulties to a number of construction businesses, as profits were hit by lack of site access and disruption to transport and deliveries.

### **Vulnerability to supply chains**

Supply chains in the construction sector vary but in many cases are complex and expansive. Large contractors vet and check up on their subcontractors and suppliers as they are highly dependent on their reliable operation, having to cover any losses or delays that are made. Subcontractors tend to use local labour and materials where possible, but inevitably have to use goods sourced from regional and global supply chains (as a general rule a third local, a third regional and a third global). The complexity and length of supply chains is generally not dependent on the size of businesses but can depend on the business type. For example, cladding companies that use cedar from Devon and slate from Cornwall will have chains that are concentrated nationally.

Supply chains used by construction businesses are diverse, often unregulated and reactionary to market changes. Backup suppliers are not always in place but the competitive nature of the industry means that suppliers can be changed as competition affects the prices of products. While supply chains are generally secure for standard items vulnerabilities do exist with unusual

products that are produced by a very small number of suppliers and backup suppliers are not in place. The risks to supply chains are seen as low by many businesses due to the low probability of events, but the severity of consequence to certain supply chains is very high as supply chain problems could trigger extreme sector disruption. Bigger businesses are also likely to have less difficulty when sorting out problems with suppliers and subcontractors due to their buying power, whereas smaller companies are easily replaceable and lose business if they make mistakes.

Some work is being done by sector organisations but the majority is guiding for sustainability and good business, rather than helping to understand and prepare for the impacts of climate change. It was agreed in the interviews that public sector organisations have more responsibility than private sector businesses to sustainability and climate change mitigation and that standards vary slightly between the two. The construction sector is seen as reactionary rather than preparatory and unlikely to change unless problems become more frequent.

## **8. Summary**

Each of the key sectors studied has a number of vulnerabilities to the potential impacts of climate change, both directly through extreme weather events and indirectly through disruptions to services and supply chains. The nature of this vulnerability varies from business to business and sector to sector, but there are a number of indicators that can dictate levels of vulnerability.

The geographical location of a business is a key indicator to vulnerability from extreme weather and climate change. Flooding – generally attributed as the extreme weather event carrying the highest level of risk – is largely dependent on the geographical location of a business. Locations that are particularly vulnerable to flooding are those in low-lying or coastal regions. This is a concern to the South West region as many business centres are located on or near the coast (Plymouth, Exeter) and the region in general is relatively low-lying. Location may also dictate vulnerability to access and transport network disruptions; businesses that are reliant on a single road or rail link are more vulnerable than those that have multiple access routes.

Vulnerability to water shortages and high temperatures are not as influenced by geography as flooding. Shortages influenced by higher temperatures are likely to hit all areas in the South West as regional temperatures gradually rise.

All vulnerabilities are largely time dependent, whereby the longer a disruption lasts the more damage is done to a business. The food and drink manufacturing sector is the most vulnerable to short-term disruptions due to the short life-cycle of many of its products and the damage that would

therefore occur to stock through indirect disruptions. Long-term disruptions pose a risk to all sectors, with different levels of vulnerability expected depending on the type of disruption (for example, the construction sector is more resilient to power supplies) and levels of preparedness.

One of the key challenges to addressing vulnerability and improving resilience to the potential impacts of climate change across the South West is engagement with SMEs, as many are not prepared for climate change risks. Due to the small size of SMEs the largest part of their exposure to climate and weather is likely to be through their supply chains. Engaging with SMEs on vulnerabilities to current weather patterns (which are expected to increase) will benefit them even in the absence of climate change.

While some do acknowledge that risks are present these risks are often underestimated or disregarded as unlikely to occur by smaller businesses. Smaller businesses are also seen as being more vulnerable to the impacts of climate change, as they do not have a large resource base to fund adaptation or respond and are focussed on short-term economic performance. The short-term planning horizons of small businesses do not permit long-term preparation for potential impacts, which are generally seen as unlikely to occur. The balancing of probability and severity is often undervalued by businesses, particularly smaller ones and results in a low priority in business plans. While some do identify potential severe weather and climate impacts, it is not uncommon for both the probability and severity of an event to be underestimated. This is a key issue to the South West due to the high numbers of SMEs operating in the region.

The benefits to an individual business of spending time on adaptation will vary greatly as vulnerability is not spread evenly across businesses. Many businesses are unlikely to deal with climate change adaptation as a separate issue, with many being unwilling to spend time and effort preparing something that is uncertain. Business continuity planning and risk management offer methods for incorporating adaptation to climate change through adaptation to current and short-term risks. It is also advisable to concentrate on high likelihood, low impact issues first.

Priorities could change as the economic situation improves or events occur more frequently because businesses are starting to see how vulnerable they are to extreme weather events through experiences such as the floods of 2007 or the snowfall of January 2010. One of the main obstacles however is that many businesses are not connecting such extreme weather events to climate change, but seeing them as freak occurrences that will not increase in frequency or severity. The majority of businesses are not learning from these experiences or putting them into practice in business planning unless they are directly affected by them.

The improvement in environmental performances in recent years that some (generally larger) businesses have made is largely attributed to a response to

consumer preferences as environmental issues have become more important in the public domain, not as a response to the threats of climate change or extreme weather events. While this shows that some businesses are giving more attention to environmental issues such as extreme weather and climate change in their planning, it is more a focus on protecting against competition than protecting against risks.

Generally speaking, shorter, simpler supply chains are more resilient than long, complex ones as, theoretically, there is less that can go wrong with them. However, for some businesses long, complex supply chains are needed due to the limited number of manufacturers and suppliers that there are for particular products or parts. The vulnerability of a businesses supply chains can be reduced by ensuring all suppliers are vetted and regularly examined, dual-sourcing is used where possible, and that suppliers have adequate risk and response plans in place. Some interviewees admitted that they know of good examples in supply chain management and resilience, but in the case of bad examples a lot of work is needed to repair the problems. One suggestion is that chains that operate with good practice are worked on to provide good case studies and improve and create toolkits for inter and intra-sector help.

Across the interviews conducted it became clear that individual businesses are expected to do their own business planning and risk assessments. While sector groups and organisations provide a range of assistance it is essentially up each business to ensure its own safety.

## **8.1. Limitations**

The biggest limitation of the project was time. Initially four weeks were put aside for interview completion but interviews continued for a further two weeks. In total 10 interviews were completed as some of the interview contacts were unable or unwilling to give interviews during the six weeks due to heavy workloads and holiday commitments, and ideally a longer timeframe for the interviews may have permitted a larger number being conducted. The time limitations also affected the ability of the study to contact individual businesses regarding vulnerability to climate change and extreme weather events to enrich the information provided by sector representatives.

Due to the time constraints that some key contacts were experiencing three of the interviews were relatively short (SWRDA – construction side, SWMAS, and Highways Agency), and as a result less informative. There were also limitations with data recording as some interviews were conducted without audio recording inevitably meaning that some information was left out and the interviews were not conducted as smoothly.

It is also important to acknowledge that the research topic is highly subjective and as such interviewees could only give their opinion on businesses vulnerability. Due to the localised nature of many extreme weather events it is

also important to acknowledge that a sectoral or regional view cannot be given in some instances. There is space for future research into the relationship between supply chain complexity and vulnerability; further understanding of this complex relationship may help to reduce any uncertainty and identify business vulnerabilities.

## **8.2. Conclusions**

It is clear from the research conducted that the potential impacts of climate change pose a number of threats to the continued operation of many businesses in the South West. The issues facing the South West are similar to other regions and the lack of awareness amongst businesses and sector groups are a national issue and not confined to the South West. Businesses in each of the four key sectors examined are vulnerable to a range of direct and indirect impacts. Awareness of these impacts is low, particularly amongst smaller businesses that underestimate the impacts and are not aware of their vulnerability - either directly or indirectly - to extreme weather events.

Generally speaking, smaller businesses are the most vulnerable to both direct and indirect impacts of climate change but the vulnerability of each is dependent on a large number of factors. The nature of business vulnerability is complex and similarly dependent on a wide range of factors. Certain sectors are more vulnerable to specific service disruptions but in general power and telecommunication loss carry the highest level of risk and would have the largest impact if lost. Loss of supply chains - in particular key suppliers - also carries a high level of risk to South West businesses and this can be exacerbated by an overestimation of supply chain resilience and reliability.

A lack of planning and preparation for such events is common across all sectors, predominantly amongst smaller businesses that are focused on their financial situation - with many still in survival mode following the economic downturn. Geographical location is a key factor in business vulnerability and is a key regional vulnerability due to the positioning of many businesses in the South West on low-lying or coastal land.

The extent of activity on climate change adaptation by business support organisations is relatively low. Assistance to South West businesses is largely limited to planning for sustainability or responses to problems that have already occurred. There is a lot of room for helping businesses to understand and plan for the potential impacts of future climate change and help increase awareness amongst businesses of the risks that they face.

Due to the wide range of factors that influence businesses vulnerability there can be no single approach to climate change adaptation.

### **8.3. Recommendations**

It is recommended that future work by Climate SouthWest primarily targets SMEs and looks to increase knowledge on the risks associated with climate change, the methods of adaptation available to businesses, the importance of including risk and response plans in business planning, and most importantly helping businesses to build their adaptive capacity.

Due to resource limitations and the existence of available tools such as the UKCIPs BACLIAT (Business Areas Climate Impacts Assessment Tool) tool there is no need for Climate SouthWest to develop methods for supporting businesses directly, instead pointing businesses across the region to the existing tools and encouraging their use. This report recommends that Climate SouthWest instead focuses its efforts on working with sector groups and business support organisations such as Business Link to highlight potential impacts to South West businesses and increase awareness of the adaptation methods that are available.

Due to the relative lack of support relating to climate change, weather-related risks and adaptation offered by many sector support groups and organisations, it is also recommended that Climate SouthWest propagate the value of such support to business sector groups. This is of particular importance due to the widespread lack of awareness relating to the risks of weather-related impacts and climate change that is prevalent amongst businesses in the South West. Some businesses have taken action to improve their environmental performance but this has largely been due to changing consumer preferences and government regulations rather than being driven by issues of climate change and extreme weather events. It is therefore important that Climate SouthWest and other organisations help to increase awareness of vulnerability to climate change and extreme weather events when engaging with businesses to encourage them to take proactive steps to increase resilience.

The use of positive messages and communication in engaging businesses with climate change information may also help to foster a more positive response, greater uptake of information and more active development in adaptive measures from businesses. It may also be beneficial to reduce the emphasis on 'climate change' when communicating with businesses due to the high level of climate change scepticism that is prevalent across many businesses (as identified in the interviews). By taking a less 'climate change' focussed approach it is possible that business participation, awareness and knowledge may be increased. It is also recommended that recent examples of business vulnerability issues such as the Gloucestershire floods are used when advising businesses on the issues of risk that they face. By placing a strong emphasis on previous and current events instead of future events that are viewed by many managers and business leaders as uncertain it may be possible to achieve a more positive response from businesses.

The improvement of entry level risk assessments may improve new business knowledge and awareness to the impacts of climate change and extreme weather events and encourage a more positive response from new start-ups. Similarly, by working with organisations involved in providing business planning and contingency planning support services to businesses, a more prominent inclusion of climate change and its potential impacts as a business risk can be encouraged by Climate SouthWest. It is important that business and contingency planning are encouraged amongst businesses in the South West region.

It is suggested that effort is primarily focussed on businesses which display key indicators of vulnerabilities. Such businesses include those that...

- are in strategically important sectors to the South West
- are in vulnerable locations such as flood zones
- have particularly vulnerable operations to disruptions and no back up systems in place
- have already suffered from extreme weather-related issues
- are involved in making long-term decisions
- are particularly small and have very limited resources

It is important that Climate SouthWest works closely with relevant partners in its key sector groups to highlight the challenges and opportunities that may arise from climate change; and the methods of adaptation and response that can be utilised to negate these challenges or make use of the opportunities.

## 9. Appendices

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## ***Appendix 2: Interview questions***

1. What is the average size, in numbers of employees, of businesses within your sector?
  - less than 10
  - 10 to 50
  - 50 to 100
  - 100 to 250
  - 250+
  
2. In your opinion, to what extent are the risks from extreme weather considered in business planning/risk assessment processes across your sector?
  - Please give evidence/examples where possible. If risks are not considered, why do you think this is?
  
3. Are you aware of potential opportunities to your sector resulting from extreme weather and the impacts of climate change? If yes, please give details.
  - Do you think that businesses themselves are aware of/acting to maximise these opportunities?
  
4. Which of the following weather events would you say businesses in your sector are most vulnerable to?
  - Flooding/heavy rain
  - Water shortages
  - High temperatures

- Please rank in order of most vulnerable and expand i.e. why are they vulnerable? What are the most significant consequences of these events for business?
  
5. Are there any particular examples of businesses in your sector that have been affected by any of the following: Please give details.
  - Flooding / heavy rain
  - Water Shortages
  - High temperatures
  
6. In what ways were they affected?
  
7. Are you aware of some businesses in your sector being affected more by the same weather event than others?
  - If so, what do you think the reasons for this were?
  
8. To what extent would you say your sector is vulnerable to the following service disruptions (on a scale of 1 to 5, 1 = not at all vulnerable, 5 = extremely vulnerable). Please expand / give reasons for your ratings.
  - Power supply disruptions

- Water supply disruptions
  - Telecommunication disruptions
  - Road network disruptions
  - Rail network disruptions
9. To your knowledge, have affected businesses taken actions or changed practices in order to reduce the impacts of future service disruptions?
- Do you feel that they would be adequately prepared for such disruptions if they were to occur again?
10. Do businesses in your sector typically rely on local, national or international suppliers?
- How expansive/complex are these supply chains? (on a scale of 1 to 5, 1 = very simple with only a few, local businesses in the supply chain, 5 = very complex, with a large number of national or international businesses in the supply chain.
11. How vulnerable do you feel the supply chains of businesses in your sector are to the impacts of severe weather? (on a scale of 1 to 5, 1 = not at all vulnerable, 5 = extremely vulnerable) Please give reasons.
12. Is your organisation/sector doing anything to help businesses prepare for weather related risks/impact of climate change? If so, please give details.

### ***Appendix 3: List of Interviewee organisations***

#### **Advanced Engineering**

South West Regional Development Agency  
EEF

#### **Transport & distribution**

Highways Agency  
Road Haulage Association  
National Rail

#### **Food & drink manufacturing**

South West Regional Development Agency  
South West Food and Drink  
South West Manufacturing Advisory Service

#### **Construction**

South West Regional Development Agency  
Cornwall Development Company