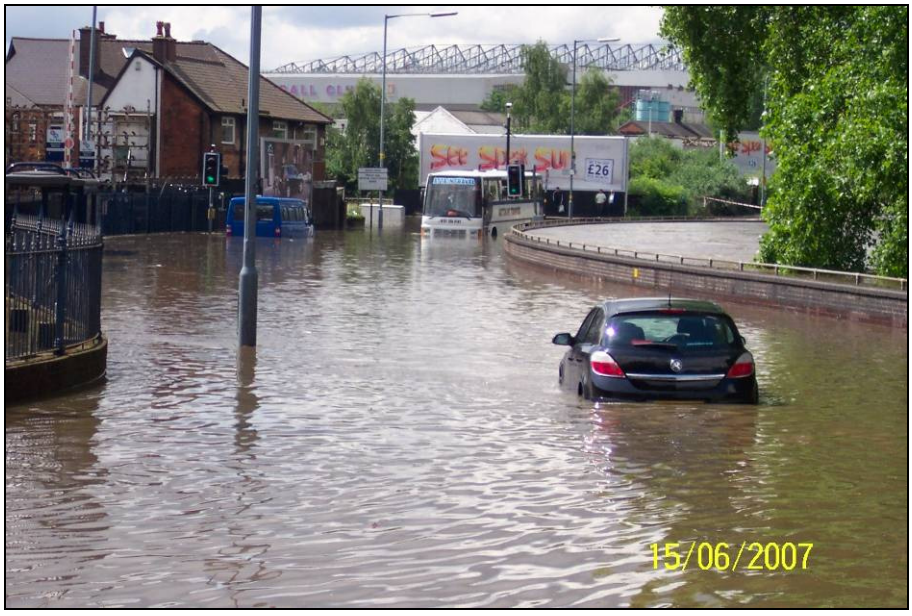
West Midlands Climate Change Adaptation Partnership

Climate Change Adaptation & Resilience Study

Summary Report

July 2010



Halcrow Group Limited

West Midlands Climate Change Adaptation Partnership

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Summary Report

July 2010

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Draft Report	10/05/10	*P Whelan*
2	1	Final Report incorporating comments from AWM	06/06/10	P Whelan
3	2	Inclusion of further comments and photographs	28/06/10	P Whelan

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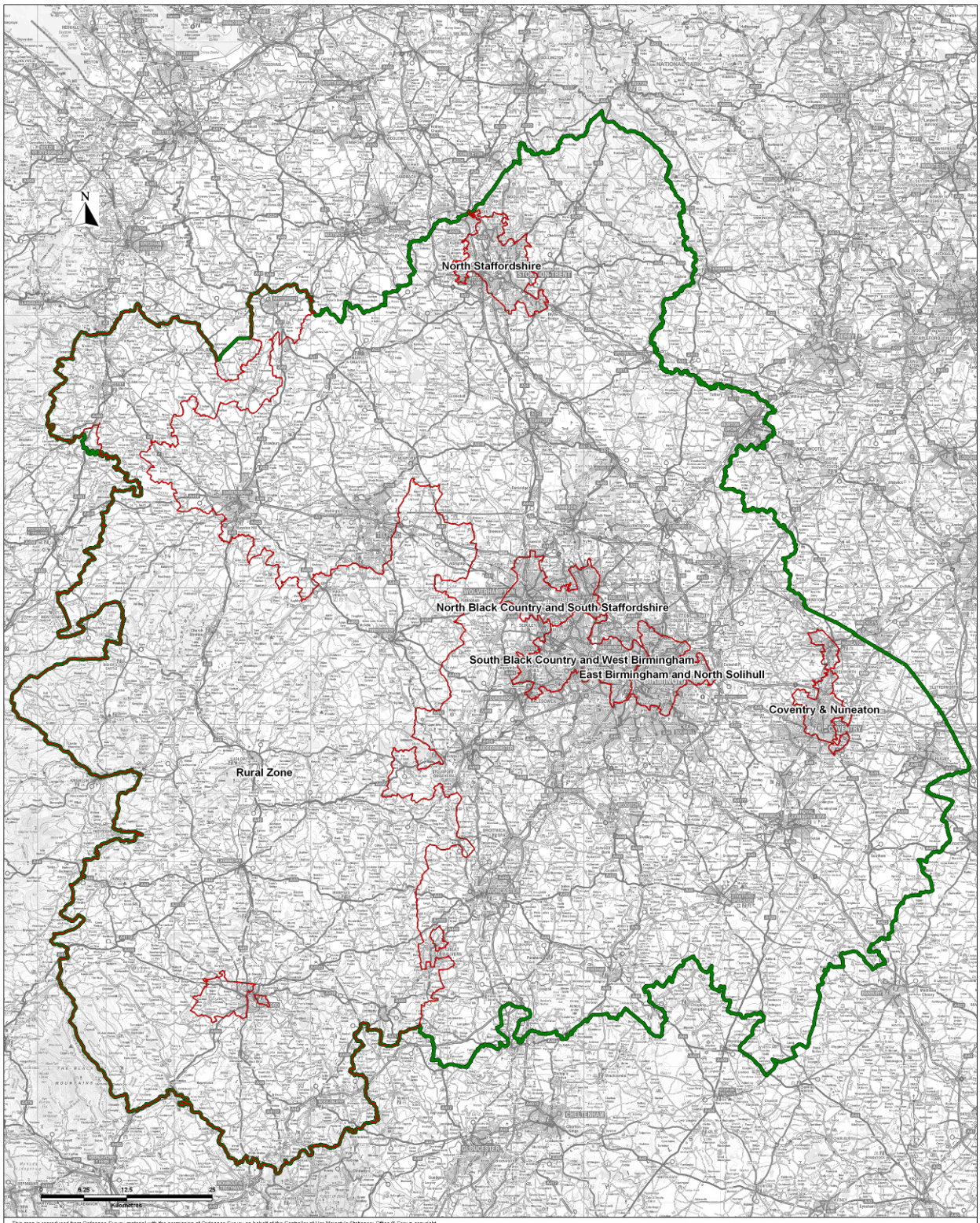

Project:- ADVANTAGE WEST MIDLANDS CLIMATE CHANGE ADAPTION STUDY

Figure 1:- REGENERATION ZONES OVERVIEW MAP

Rev.	By	Date	Description

Keyplan:-

Legend:-

- West Midlands Regional Boundary
- Regeneration Zones

Drawn By	:- A J Bryan	Revision	Drawing Scale	:- 1:250,000	Drawing No.	:- WM/AWMS/DRAWING - 001	
Checked By	:- C H Mills	-	Sheet No.	:- 1 of 1	Date	:- 11th January 2010	
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Executive Summary

Flooding is one of the main outcomes of extreme weather experienced within the West Midlands and is projected to become more frequent in the future due to climate change. This summary report presents an overview of the flood risk assessment and the business area flood risk mapping for the region, the economic implications of these impacts, and the likely consequences of climate change on business under UKCP09 projections.

Flood risk is an important consideration within the West Midlands and, with the impacts of climate change predicted in the future, this risk is likely to increase. This may have catastrophic impacts on the region's economic activity and the quality of life of its communities. Advantage West Midlands (AWM) identified that there is a lack of evidence base upon which the potential loss of economic value (both capital and revenue) from the region's businesses may be evaluated. Whilst a number of existing studies have investigated the risk of flooding from all sources across the region, these have not focused specifically on the impact to the region's businesses. In addition, existing studies have not considered the risk of 'pluvial' (surface water) flooding in detail. Furthermore, the implications of flood risk on critical infrastructure and transport links is of importance with the summer 2007 floods and subsequent Pitt Review highlighting a deficiency in previous planning consenting, concerning the potential impacts on critical infrastructure and transport links during a flood event. These knowledge gaps are therefore constraining the provision of co-ordinated business support and detracting business from planning for climate change.

The flood risk mapping exercise undertaken provides an evidence base for local businesses to help highlight the importance of implementing climate change adaptation measures. It has also been used to inform the further elements of this Climate Change Adaptation and Resilience Study as a whole with a view that potential opportunities will be communicated to stakeholders and adaptation measures can then be incorporated into the regional planning policy framework, so that Local Authorities can consider such measures in their Local Plans.

Considering the global variations in the effects of global warming and lack of detailed information on economic and monetised impacts, the changing climate poses a clear threat to economic activity in the West Midlands. The economic assessment initiated the process by appraising existing evidence on the past climate change events within economic sub-regions of the West Midlands. A major limitation of the existing evidence is the lack of monetized information related to business activity.

This makes raising awareness of the impact of climate change amongst businesses and need for adaptation as part of their business planning process a challenging task. Such trends were also resonated by the local businesses through the survey. In particular, two thirds of businesses surveyed were affected financially by extreme weather conditions in the past twelve months. Despite such high proportion of businesses impacted, only a fraction were gearing towards establishing reactive adaptation and resilience measures as part of their business continuity planning. A key reason highlighted by most businesses for such an approach was lack of understanding of typical impacts of extreme weather events to inform the business planning process.

Preparing for a changing climate – considerations for businesses managers

a) How has a business been affected by severe weather events in the last few years; are interests, products, services or processes influenced by weather – both individual events and longer term changes?
b) because of these events, has the business taken any action to mitigate risk (climate risk management / adapting to climate change); does the business continuity plan include weather related events or climate change?
c) is the business resilient to future climate change; a strategy of "no regrets" adaptation may be the best approach - climate proofing does not always incur additional costs!
d) decide on the options that exist and whether you can adapt in several steps – e.g. every 5 or 10 years, especially if you're involved in making decisions with long-term consequences..

Using a case study approach for individual business parks, the reports seek to build that evidence base, which would facilitate more effective business planning by the local enterprises. Such an approach would safeguard any loss of business activity and associated economic value in the West Midlands. In particular, ***the analysis concludes that the average impact on businesses turnover, at approximately £18 per sq m per day, as a result of an extreme weather event is significantly more than the capital damage***. Such scale of monetary impact along with the longevity of the impact on business operations could result in significant loss of economic outputs, and importantly, loss of business activity in the region.

Studies in the last few years have shown that many businesses in the UK are not adequately preparing to cope with weather-related disasters and that the cost of business down-time as a result of severe weather impacts may be significantly greater than damage to property, equipment and goods. In order to prosper, businesses need to have both mitigation and adaptation for climate change firmly on their agenda.

Each and every business assessed in this study faces several risks from severe weather events, with flooding being the most damaging. Some of the risks are direct, while others, whilst indirect, should also be considered. Exposure to these risks will increase in the future with climate change.

Businesses should carry out an impact assessment, guided by the climate change impact matrix developed for this study. A number of toolkits and documents already exist that can also be used to adapt business premises and activities and make the whole business more resilient to climate change. Such adaptation measures create an advantage for businesses.

1. Introduction

1.1. Project Aims and Introduction

1.1.1. The impacts of climate change may have catastrophic impacts on a region's economic activity and the quality of life of its communities. It is, however, evident that there is a lack of evidence base upon which the potential loss of economic value (capital and revenue) from the region's businesses may be evaluated. This knowledge gap is constraining the provision of co-ordinated business support and detracting business from planning for climate change. Unless there is a clear evidence base demonstrating the direct consequences on bottom line economics and more readily available and focussed support, business entrepreneurs will fail to develop and adopt adequate physical, structural, procedural and financial measures to protect themselves against, or seize opportunities arising from, climate change. It is therefore evident that there is a need to identify and outline the direct impacts on businesses within the region from past extreme weather conditions. This study aims to address this shortfall and provide the evidence base for the potential impacts of climate change through a case study approach. Six economic sub-regions were identified for assessment. These are:

- Coventry and Nuneaton
- North Staffordshire
- South Black Country and West Birmingham
- East Birmingham
- North Black Country and South Staffordshire
- Rural Zone

A full technical report for each of these economic sub-regions is available for review. This report presents a summary overview of the assessment undertaken for the West Midlands based on the individual economic sub-regions.

1.2. Project Objectives

1.2.1. The assessment is divided into three integrated sections: 1) Identification of flood risk, 2) the associated economic implications, and 3) a summary of how business can adapt and prepare for climate change. The assessment aims to:

- Provide an overview assessment of the flood risk issues;
- Provide a basis for quantifying the economic implications of flooding not only as a direct consequence of property damage and loss of stock, but also the down time before business is 'back to normal';
- Provide a review of existing evidence on climate change events in the sub-region and the wider region;
- Provide a survey of a sample of region's businesses at selected business parks and industrial estates, to build further evidence on impacts of past extreme weather events;
- Provide an economic impact statement for six industrial estates, focussing on the capital damage and loss of operational economic activity as a result of a typical extreme weather event;
- Provide a summary of projected climate change, adapted from the UKCP09 findings;
- Provide additional insight into heavy rainfall events not yet contained in UKCP09;
- Provide a short introduction how businesses can build up resilience & adapt.

2. Review of Local CLimate Impacts Profiles (LCLIPs)

2.1. Introduction

2.1.1. The LCLIP process highlights a locality's vulnerability to severe weather events and how these events affect local communities as well as local authority assets, infrastructure and capacity to deliver services.

2.1.2. This section summarises the findings of Local Climate Impacts Profiles (LCLIPs) across the West Midlands region.

2.2. Regional Impacts

2.2.1. LCLIP databases for the local authorities that are covered by the economic sub-regions have been interrogated to determine the number, type and impact of extreme weather events in the period between 1998 and 2009.

2.2.2. A total of 338[1] extreme weather events were reported in the various LCLIP databases for the West Midlands Region in this period. Figure 2.1 illustrates the number of events occurring in each year since 1998 across the region.

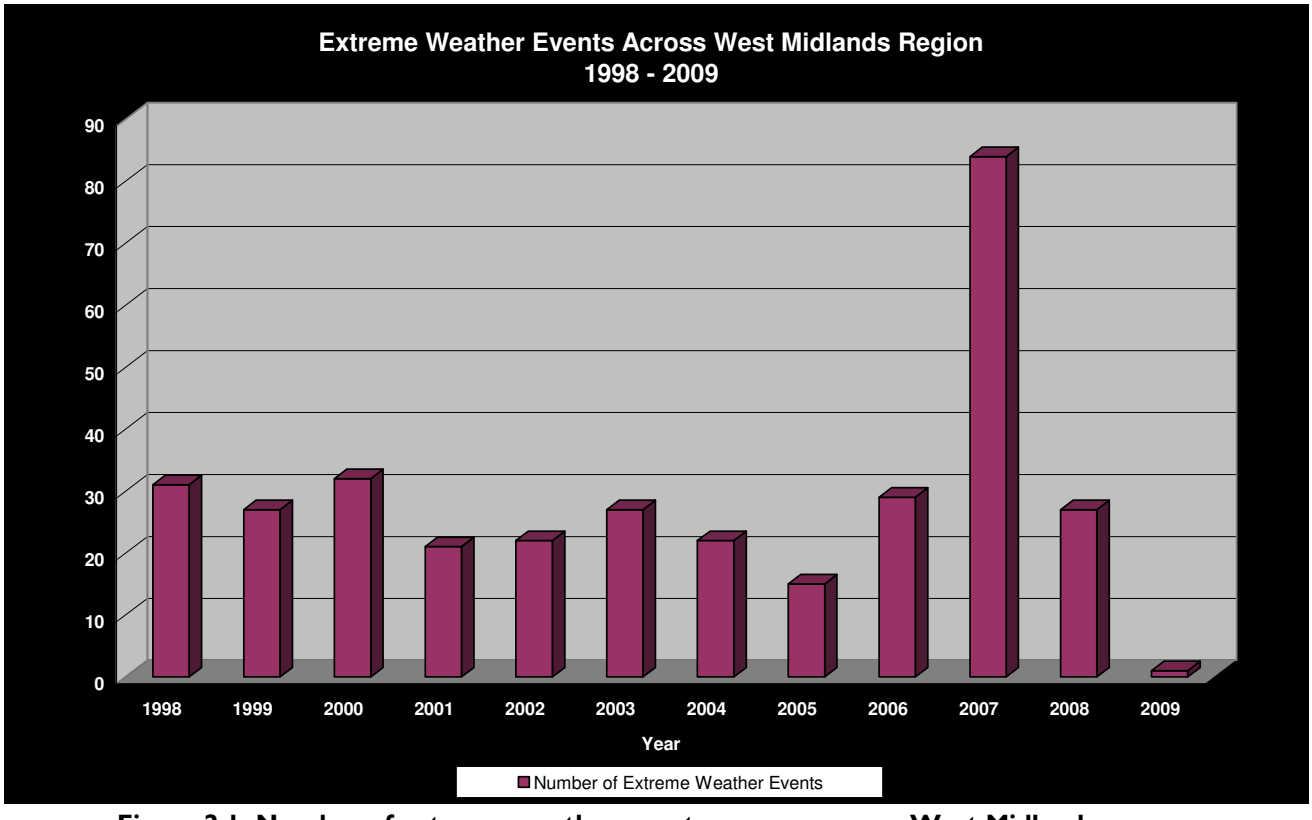

Figure 2.1: Number of extreme weather events per year across West Midlands

[1] This total includes information from Birmingham City Council, Walsall MBC, Coventry City Council, Herefordshire County Council and Shropshire County Council. Therefore the LCLIP data does not cover the North Staffordshire Regeneration Zone.

2.2.3. The number of extreme weather events across the West Midlands peaked in 2007. Other than 2007, incidents of extreme weather conditions have remained fairly consistent since 1998. A range of weather conditions can be described as extreme weather events. Figure 2.2 presents the type of events that have occurred since 1998.

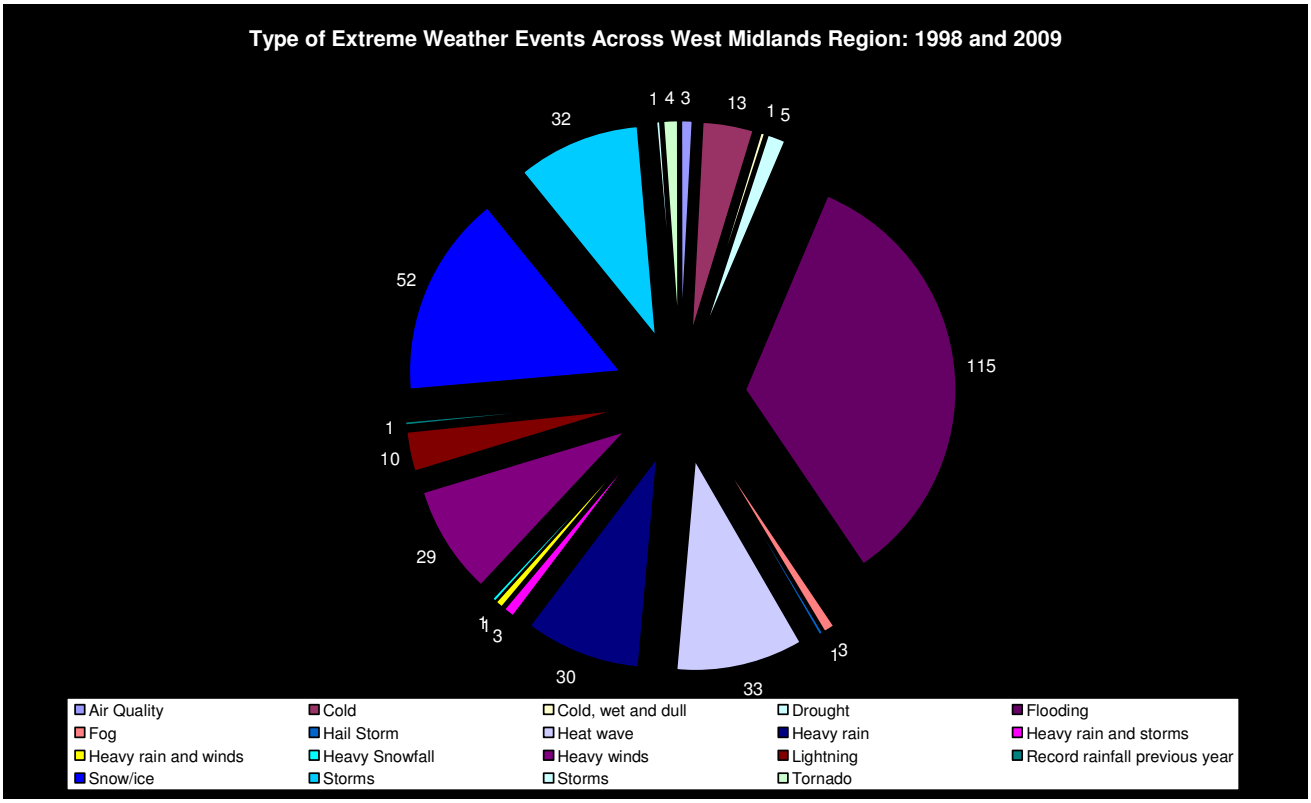

Figure 2.2: Type of extreme weather events across the West Midlands

2.2.4. The LCLIP databases recorded nineteen different types of extreme weather events across the region. Flooding was by far the most commonly occurring event (115 incidents between 1998 and 2009), accounting for over one-third of all extreme events. Snow/Ice events also occurred regularly during this period. Different types of events have varying impacts. Figure 2.3 provides information on the duration of the impact of the extreme weather events.

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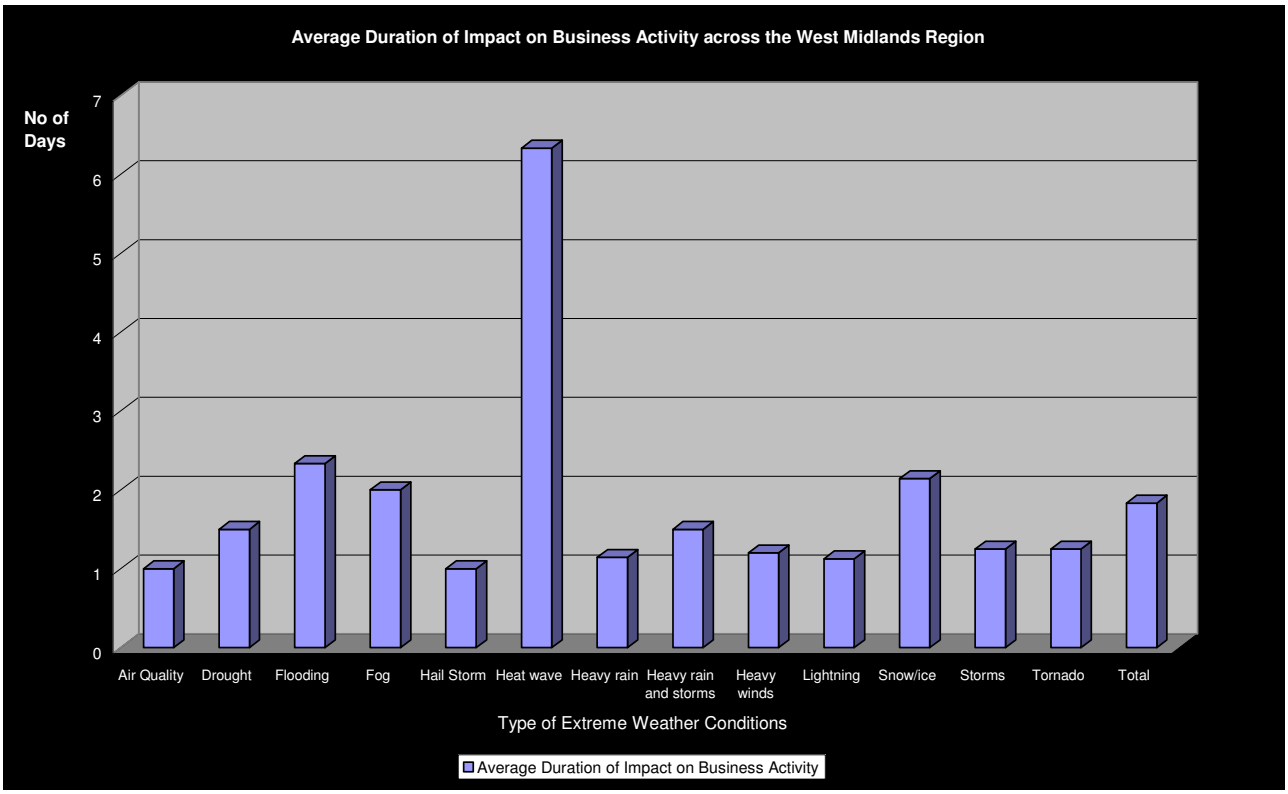

Figure 2.3: Average duration of impact on business activity across the West Midlands

2.2.5. The average duration of impact across all extreme weather events that occurred in the West Midlands Region was just under two days. However, this average masks considerable variations between different types of events. For example, hail storms had an impact of less than one day on average, whereas the impact of heat waves was almost one week.

3. Flood Risk and Climate Change

3.1. Flood Risk and Climate Change

3.1.1. Research indicates that climate change will be a major cause of increased flood risk in the future. In particular, the West Midlands is expected to experience:

- Warmer, drier summers;
- Milder wetter winters
- Significant decrease in soil moisture content in summer and autumn;
- More (and worse) extreme weather events;
- More very hot days; and
- More intense downpours of rain.

3.1.2. Overall, the above effects will tend to increase both the extent of flooding and the depth of floodwater associated with rivers, and the amount of flooding experienced from 'other sources'. Sites that are currently within the Environment Agency's Flood Zones 2 and 3 (Figure 3.1) will be subject to more frequent and potentially deeper flooding. PPS25 sets out current guidance for changes to flood risk as a result of climate change, shown in Table 3.1.

Figure 3.1 Environment Agency Flood Zones

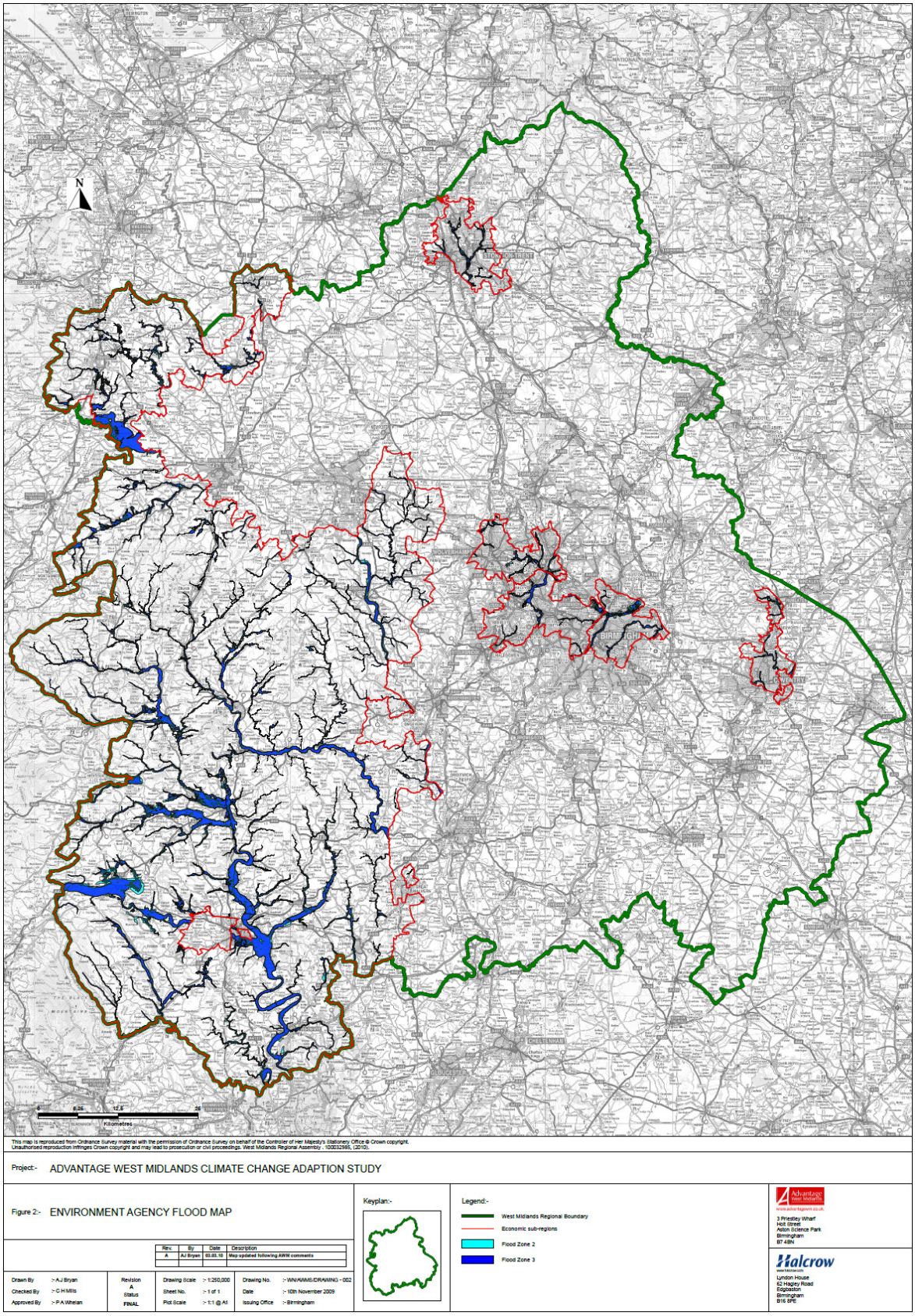

Table 3.1: PPS25 Guidance for Changes to Flood Risk as a Result of Climate Change

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

3.1.3. The UK Climate Projections (UKCP09)[2] estimate that for the West Midlands there will also be a higher risk of more frequent and extreme weather events, such as storms and flooding, particularly associated with the increased likelihood of heavier downpours in both summer and wintertime (USR, 2007)[3].

3.1.4. Table 3.2 demonstrates the mean annual, winter and summer precipitation (rainfall) projections for the West Midlands at the 10, 50 and 90% probability levels, by the 2050s under the medium emissions scenario. In addition, the table shows a wider range of uncertainty for the 2050s, defined here as the lowest and the highest values seen in all three emissions scenarios and all three (10, 50 and 90%) probability levels. In the case of precipitation, change in the annual mean is also shown.

Table 3.2: UKCP09 projected changes in precipitation to 2050 for the West Midlands

Probability Level / Parameter	10%	50%	90%	Wider Range	
Annual Mean Precipitation (%)	-4	0	+6	-5	+6
Winter Mean Precipitation (%)	+2	+13	+28	+1	+31
Summer Mean Precipitation (%)	-36	-16	+6	-38	+14

3.1.5. As with fluvial flooding, the impacts of climate change will have a significant effect on flood risk from other sources within the region such as surface water, groundwater, artificial drainage, impounded water bodies and infrastructural failure. In the future, rainfall events are likely to increase in frequency, intensity and duration. Such changes will affect all sources of flooding and will have implications for both existing and proposed development. The implications of flooding from all sources to both existing businesses and future business within the West Midlands

[2] The UK Climate Change Projections (UKCP09), http://ukclimateprojections.defra.gov.uk/content/view/868/531/ (Accessed February 2010)
[3] USR (2007) 'The Impact of Climate Change on the Economy of the West Midlands'

therefore require careful consideration. Where flood risk issues are identified within existing business parks and trading estates these will need to be appropriately managed.

3.1.6. Table 3.3 below presents the current and future flood risk under climate change for each of the economic sub-regions covered as part of this study. A more detailed assessment is provided within each of the main reports covering the economic sub-regions.

3.1.7. Businesses should ensure that safe access and egress to their site can be maintained during a flood event. Alternative access routes should be identified in areas known risk areas to ensure both emergency vehicles and employees of the business can get to and from the site to minimise disruption.

3.1.8. For any future development within existing sites, or for new sites proposed within the region, critical infrastructure should be directed towards Flood Zone 1. Where this cannot be achieved, the Pitt Review recommends that critical infrastructure should be designed and constructed to remain operational and safe for use in at least a 0.1% Annual Exceedence Probability (AEP) event.

Table 3.3 : Present Day Inherent Flood Risk and Climate Change Inherent Flood Risk within the Six Economic sub-regions

Economic sub-region	Total Area (Km^2)	Present Day Inherent Flood Risk		Climate Change Inherent Flood Risk		Change in Flood Risk	
		Total Area in Flood Zone 3 (km^2)	% Area in Flood Zone 3	Total Area in Flood Zone 2 (km^2)	% Area in Flood Zone 2	Change in Total Area in Flood Zone 3 (km^2)	Change in % Area
Rural Sub-region	4873	306	6.3	369	7.6	63	1.3
North Staffordshire	101	4	4.3	6	5.8	2	1.6
North Black Country & South Staffordshire	87	4	4.4	6	6.6	2	2.3
South Black Country & West Birmingham	135	6	4.7	9	6.3	2	1.7
East Birmingham & North Solihull	85	6	6.9	9	10.1	3	3.3
Coventry & Nuneaton	61	3	4.7	4	6.9	1	2.2

4. Assessing the economic impact of weather events

4.1. Introduction

4.1.1. This section highlights the potential economic impact of extreme weather events. The operational (i.e. loss of economic activity and business turnover) and capital cost of extreme events are considered.

4.1.2. As the LCLIP databases do not provide complete economic data, the impact of extreme weather events on business activity and the wider economy has to be derived using a series of case studies. Six business parks in the West Midlands Region that are already at risk to extreme weather events (e.g. flooding) were assessed, to cover each of the economic sub-regions within the West Midlands.

4.2. Approach

4.2.1. The economic impact of extreme weather events is estimated using a reference case value developed for the case study business parks. The reference case value is translated into an economic value of impacts by understanding the recovery time of businesses reacting to extreme weather events. This provides an operational cost of extreme weather. The capital cost of events is determined through capital damage analysis.

4.2.2. There are two components of the operational cost of extreme weather events; business activity losses and wider economic value losses. The annual business turnover of all companies within each business park provides an indication of business activity at each site. The wider economic value of each site is calculated according to the two following economic effects:

- Direct income injection into the economy;
- Government revenues.

4.2.3. The direct income injection into the economy comprises the wages of employees working at the business parks. It also takes into account the income arising from direct business expenditure and business profits likely to be invested into the local economy. A composite multiplier effect is also included. This considers the supply

chain effect of local spending by businesses that receive direct income from economic activity on the business parks, and the induced income effect of business park employees spending on local goods and services.

4.2.4. The government revenue effect relates to income generated for local and central government through taxes on business and employees as well as business rates payable by companies.

4.3. Operational Impact of Extreme Weather Events

4.3.1. An assessment has been undertaken to determine how long it takes different types of businesses to return property to operational standard following an extreme weather event (in this case, flooding). The 'recovery time' of businesses takes into account factors such as repair to building fabric, liaising with insurance brokers, replacing stock and re-establishing commercial operation (although these factors may vary between types of businesses).

4.3.2. Following a 1 in 100 hundred flooding event, the recovery times assumed for different types of businesses are displayed in Table 4.1 below:

Table 4.1: Business recovery times across

Land Use*	Best Case Scenario: Recovery Time (weeks)	Worst Case Scenario: Recovery Time (Weeks)
B1	12	49
B2	16	46
B8	8	29
Leisure	12	49

* B1 is Office Based, B2 is Warehouse / Distribution, and B8 is Manufacturing

4.3.3. The estimated average recovery time covering all land use types is estimated at 27 weeks.

4.4. Economic Loss

4.4.1. The average economic value and turnover for the business parks considered as part of this study has been established, along with the recovery time for types of businesses found at the site. This data allows the average operational cost of extreme events to be calculated. The capital cost of weather events has been derived from capital damage analysis. Table 4.2 provides a final summary of the annual economic impact of a 1 in 100 flooding event within business parks located in the West Midlands. A breakdown of the impacts by individual business park with respect to operational and capital costs is presented in Table 4.3 and the predicted loss per extreme weather event per m2 of business area is presented in Table 4.4.

Table 4.2: Scale of economic impacts from flooding (averaged across the study business parks)

Loss Indicator	Best Case Scenario	Worst Case Scenario
Operational Loss (Business Turnover and Economic Activity)	£20,720,023	£71,920,523
Capital Damage	£227,167	£227,167
Total Loss Per Event	£20,947,190	£72,147,690
Per sqm Total Loss Per Event	£1,113	£3,810

Table 4.3 Predicted loss (per flooding event) by Business Park

Business Park	Regeneration Zone	Operational Cost		Capital Cost
		Best Case	Worst Case	
Rednal Industrial Estate, Oswestry	Rural	£ 2,920,291	£ 10,648,229	£ 23,000
Berry Hill Industrial Estate, Stoke-on-Trent City	North Staffordshire	£ 27,988,914	£ 109,748,690	£ 168,000
Axcess 10 Business Park, Darlaston, Walsall	North Black Country and South Staffordshire	£ 20,397,430	£ 59,730,174	£ 137,000
Electra Park – by Brookvale Road, Birmingham	South Black Country and West Birmingham	£ 16,241,517	£ 56,347,517	£ 174,000
Saltley Trading Estate, Birmingham	East Birmingham and North Solihull	£ 52,895,251	£ 182,666,289	£ 816,000
Seymour Road, Nuneaton & Bedworth	Coventry and Nuneaton	£ 3,876,734	£ 12,382,241	£ 45,000

Table 4.4. Predicted loss by Business Park (per flood event per m2)

Business Park	Economic Sub-region	Total Cost		
		Best Case	Average Case	Worst Case
Rednal Industrial Estate, Oswestry	Rural	£ 620	£1,434	£ 2,248
Berry Hill Industrial Estate, Stoke-on-Trent City	North Staffordshire	£ 1,966	£4,821	£ 7,676
Axcess 10 Business Park, Darlaston, Walsall	North Black Country and South Staffordshire	£ 1,586	£3,106	£ 4,625
Electra Park – by Brookvale Road, Birmingham	South Black Country and West Birmingham	£ 692	£1,538	£ 2,384
Saltley Trading Estate, Birmingham	East Birmingham and North Solihull	£ 764	£1,687	£ 2,610
Seymour Road, Nuneaton & Bedworth	Coventry and Nuneaton	£ 1,047	£2,183	£ 3,319
AVERAGE	-	£1,113	£2,461	£3,810

4.4.2. Using the average overall case of economic loss of £2,461 per m^2 per event, and a estimated average recovery time of 27 weeks, this gives approximately **£18 per m^2 per day loss** to business during an extreme weather event (based on operational and capital costs).

5. Climate Change Adaptation & Resilience for Businesses

5.1. Introduction

5.1.1. Severe weather events, such as flooding, are on the rise and are disrupting daily life and business activities where they strike. Under climate change the frequency and severity of such events are predicted to increase, hence it is important to prepare for increased weather-related risks. Numerous studies in the last few years have shown that many businesses in the UK are not adequately preparing to cope with weather-related disasters and that the cost of business down-time as a result of severe weather impacts may be significantly greater than damage to property, equipment and goods.

5.2. Projected changes and risks for West Midlands

5.2.1. For the West Midlands, under a medium-emission scenario, for mid-21st century, the UKCP09 [4] projections are:

- central estimate of increase in **winter mean temperature** is 2.1°C; it is very unlikely to be less than 1.2°C and is very unlikely to be more than 3.2°C.
- central estimate of increase in **summer mean temperature** is 2.6°C; it is very unlikely to be less than 1.2°C and is very unlikely to be more than 4.4°C.
- central estimate of increase in **summer mean daily maximum temperature** is 3.6°C; it is very unlikely to be less than 1.3°C and is very unlikely to be more than 6.5°C.
- central estimate of increase in **summer mean daily minimum temperature** is 2.7°C; it is very unlikely to be less than 1.1°C and is very unlikely to be more than 4.8°C.
- central estimate of change in **annual mean precipitation** is 0%; it is very unlikely to be less than –5% and is very unlikely to be more than 6% (see table 2.2).
- central estimate of change in **winter mean precipitation** is 13%; it is very unlikely to be less than 2% and is very unlikely to be more than 27% (see table 2.2).
- central estimate of change in **summer mean precipitation** is –17%; it is very unlikely to be less than –37% and is very unlikely to be more than 6% (see table 2.2).

5.2.2. On the last projection it is important to note that there could be an **increase of intense precipitation / rainfall events**, even if projections for average (or mean) precipitation in summers are pointing at a decrease. This is due to convective rainstorms, which are not simulated by the current generation of climate models. New science is also emerging that winter precipitation could

[4] See UKCP09 - URL http://ukclimateprojections.defra.gov.uk/

increase much more than projected, due to previously not well understood processes in the upper atmosphere.

5.2.3. In the short term, (natural) climate variability will dominate, though in the next couple of decades, the signal from anthropogenic climate change will become more important and from about mid-century will dominate.

5.3. Preparing for a changing climate

5.3.1. Considerations for Managers:

a) ask yourself if your business (including staff, supply chain and externalities such as utilities) have been affected by severe weather events in the last few years; are your interests, products, services or processes influenced by weather – both individual events and longer term changes?

b) because of these events, have you taken any action to mitigate risk (climate risk management / adapting to climate change); does your business continuity plan include weather related events or climate change?

c) consider whether you have done enough to make your business resilient to future climate change; a strategy of "no regrets" adaptation may be the best approach - climate proofing does not always incur additional costs!

d) decide on the options that exist and whether you can adapt in several steps – e.g. every 5 or 10 years, especially if you're involved in making decisions with long-term consequences.

5.4. Case Studies – Sector Based Details

5.4.1. For the businesses assessed in this study, we developed an impacts matrix that lists the likely impacts for a number of weather variables, analysed for each business sector (See Appendix A). The weather variables were ranked according to impact strength:

- **High**: rainfall intensity
- **Medium-high**: max daily summer temperatures, peak wind speed
- **Medium**: rainfall seasonal changes, seasonal temperature, mean wind speed
- **Low**: max daily winter temperatures, snow, humidity

5.4.2. The following sectors were included in the matrix:

- Office based (Land use type B1)
- Warehouse / Distribution (Land use type B2)
- Manufacturing (Land use type B8)
- Leisure

5.4.3. Many sub-activities have been analysed, e.g. under "common issues" we examined building exterior (including roof), grounds (including access and parking), supply of utilities (electricity, gas, water) and green infrastructure (see Appendix A for matrix).

5.5. How do businesses react to these conclusions?

5.5.1. In previous studies[5] only a small percentage of businesses were reasonably aware of their risks to climate change, notably energy utilities and the reinsurance sector. There are some leaders in this field (energy utilities and reinsurers), who are mainly well resourced and tend to be exposed to climate change risks on a large (and often global) scale. These organisations have been preparing themselves for some time. Smaller businesses often lack the resources to undertake studies themselves. However, several guides have been produced to help them[6,7,8].

5.5.2. Following a recent consultation event in a Birmingham business park (within the South Black Country and West Birmingham economic sub-region), it was noted that climate change adaptation did not seem high on businesses' agendas – these issues are probably only on the forefront of manager's interests right in the aftermath of a severe weather event.

5.6. How should businesses build up resilience?

5.6.1. Taking action to increase resilience against severe weather events is important for the long-term sustainability of businesses. Businesses will be in a far better position to prevent losses, survive, prosper and gain an advantage over less prepared competitors.

5.6.2. Steps to increase resilience include:

- **Identifying the risks:** Understand which types of weather events pose a risk for your business
- **Understanding the degree of change projected:** Determine whether severe events will become more frequent and/or more intense
- **Adaptation planning:** Investigate what options exist for adapting to these risks and which are likely to be most effective – both in cost and damage & downtime avoidance
- **Talk to relevant organisations:** Defra, Environment Agency, UKCIP (and Halcrow) can help you to adapt successfully

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[5] See e.g. Firth, J., and Colley, M. (2006) "*The Adaptation Tipping Point: Are UK Businesses Climate Proof ?*" Acclimatise and UKCIP, Oxford., can be downloaded from URL http://www.ukcip.org.uk/images/stories/Pub_pdfs/CDP4_UK.pdf

[6] Crichton, D., (2006) "*Climate Change and its effects on Small Businesses in the UK*" – URL http://www.cicero-europe.com/Research-Analysis/AXA_Climate_Change.pdf

[7] Business in the Community (BitC) – "*Adapting to climate change - a brief guide for businesses*" – URL http://www.bitc.org.uk/

[8] Eggen, B., and Huddleston, M. (2007) – "*Climate change adaptation for UK businesses – A report for the CBI Task Force on Climate Change*" – URL http://www.metoffice.gov.uk/consulting/CBI_TFCC.pdf

5.7. Further Reading

5.7.1. The following references are recommended for further reading:

- Confederation of British Industry (CBI) –
  URL http://climatechange.cbi.org.uk/

- Climate Resilience Programme (East Midlands) –
  URL http://www.climateresilience.org.uk/target_sectors.html

- Chartered Management Institute (CMI) –
  "A Decade of Living Dangerously" – URL http://www.managers.org.uk/

- "Copenhagen Diagnosis" – URL http://www.copenhagendiagnosis.org/

- Intergovernmental Panel on Climate Change (IPCC) –
  URL http://www.ipcc.ch/

- UK Climate Impacts Programme (UKCIP) –
  URL http://www.ukcip.org.uk/

6. Overall Conclusions and Recommendations

6.1. Flood Risk and Climate Change

6.1.1. Flood risk is an important consideration within the West Midlands and with the impacts of climate change predicted in the future, this risk is likely to increase. The impacts of climate change may therefore have catastrophic impacts on a region's economic activity and the quality of life of its communities.

6.1.2. The flood risk mapping exercise undertaken provides an evidence base for local businesses to help highlight the importance of implementing climate change adaptation measures.

6.2. Economic Impacts

6.2.1. Considering the global variations in the effects of global warming and lack of detailed information on economic and monetised impacts, the changing climate poses a clear threat to economic activity in the West Midlands.

6.2.2. Using a case study approach, the reports seek to build that evidence base, which would facilitate more effective business planning by the local enterprises. Such an approach would safeguard any loss of business activity and associated economic value in the Region. In particular, the analysis concludes that the average impact on businesses turnover, at approximately £18 per sq m per day, as a result of an extreme weather event is significantly more than the capital damage. Such scale of monetary impact along with the longevity of the impact on business operations could result in significant loss economic outputs, and importantly, loss of business activity in the sub-region.

6.2.3. The economic impact assessment concludes the need for proactive engagement within public sector and with the private sector to raise awareness about the scale of impacts. Additionally, the analysis suggests a need for good practise recommendations on building resilience and adaptation amongst local businesses against extreme weather conditions.

6.3. Adaptation and Resilience

6.3.1. Severe weather events, such as flooding, are increasing in frequency and severity and are disrupting economic activities. Under climate change the frequency and severity of such events are predicted to increase further, hence it is important to prepare for increased and potentially more costly weather-related risks.

Preparing for a changing climate – considerations for businesses managers

a) How has a business been affected by severe weather events in the last few years; are interests, products, services or processes influenced by weather – both individual events and longer term changes?

b) because of these events, has the business taken any action to mitigate risk (climate risk management / adapting to climate change); does the business continuity plan include weather related events or climate change?

c) is the business resilient to future climate change; a strategy of "no regrets" adaptation may be the best approach - climate proofing does not always incur additional costs!

d) decide on the options that exist and whether you can adapt in several steps – e.g. every 5 or 10 years, especially if you're involved in making decisions with long-term consequences..

6.3.2. Taking action to increase resilience against severe weather events is important for the long-term sustainability of businesses. Businesses will be in a far better position to prevent losses, survive, prosper and gain an advantage over less prepared competitors.

Steps to increase resilience

6.3.3. There are four steps which can help businesses to increase resilience: firstly they must identify the weather events that pose a risk to them; secondly they need to determine the range of change projected; thirdly they should investigate what adaptation options are practical and effective, and finally they ought to talk to relevant organisations and public bodies for further assistance.

6.4. Final Conclusions

6.4.1. Studies in the last few years have shown that many businesses in the UK are not adequately preparing to cope with weather-related disasters and that the cost of business down-time as a result of severe weather impacts may be significantly greater than damage to property, equipment and goods. In order to prosper, businesses need to have both mitigation and adaptation for climate change firmly on their agenda.

Appendix A

Climate Impacts Matrix

		Principal climate change impact								
		High Impact	Medium High Impact		Medium Impact			Low Impact		
Type	Element / activity	Rainfall intensity	Max daily summer temperatures	Peak windspeed	Rainfall seasonal changes	Seasonal Temperature	Mean windspeed	Max daily winter temperatures	Snow	Humidity
		Projected to increase; effects can last days - weeks	Projected to increase; effects can last weeks	Likely to increase; effects can last a few days	Increases in winter and decreases in summer; little or no annual change	Increases in all seasons projected; effect continuous	Mild decrease likely; effect continuous	Projected to increase; effect seasonal	Decrease likely; effect seasonal	Projected to decrease; effect continuous
Common Issues	Building Exterior, including roof	Leakage of roofs, enhanced corrosion	Enhanced corrosion and maintenance requirements	Wind damage						
	Grounds, including access and parking	Surface water flood risk	Softening asphalt; Dust nuisance	Hazardous conditions						
	Supply of utilities (electricity, gas, water)	Surface water flood risk leads to Increased network failure Substation risk of flooding Underground cables at risk	Impact on demand Heat waves in summer could lead to "brown outs" Transformers may not be able to cool down enough overnight	Wind damage						
	Green Infrastructure	Erosion of banks, enhanced maintenance and repairs	Wilting; changing irrigation requirements	Uprooting of trees	Drought resistant plants required	Sensitive plants may not cope				
Office based	Electricity supply / transformers	Surface water flood risk leads to Increased network failure Substation risk of flooding Underground cables at risk	Impact on demand Heat waves in summer could lead to "brown outs" Transformers may not be able to cool down enough overnight	Wind damage				Reduced cooling capacity of transformers	Overhead conductors at risk	Operational aspects
	Gas, oil and other fuels	Contamination of fuel stocks from flooding events; fuel leakage interceptors requiring larger capacity	Increased operational risk requires cooling capacity Storage and pipes could be stressed to outside limits of operating conditions	Wind damage. Operator safety risk management				Ice loading on pipes	Operational aspects	
	Telecommunication equipment / cables	Flooding and subsurface saturation leading to more maintenance and more failures		Wind damage Reduced availability Increased inspection frequencies			Maintenance of cables	Icing on wires results in reduced availability & increased inspection for damage	Cables at risk	Risk of condensation inside sensitive equipment
	IT infrastructure	At risk from roof leakages	Reduced capacity for cooling, may require extra air conditioning							Risk of condensation inside sensitive equipment
	Air conditioning	Operational aspects	Operational aspects (cooling capacity may need increase)	Wind damage, operational aspects	Retuning of equipment	Operational aspects (more cooling in summer, less heating in winter)	Operational aspects, increased maintenance		Operational aspects, increased maintenance	Operational aspects, increased maintenance
	Travel to and from office	Surface water flood risk leads to disruption in travel and transport	Road conditions could deteriorate in summer (melting of surface)	Hazardous driving conditions				Less icy roads	Hazardous driving conditions	

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	Building structures, parking, access	Surface water flood risk; leakage of roofs, water damage inside Parking areas could be flooded Access could become temporarily more hazardous (eg more slippery)	Softening asphalt Deterioration of roofing materials Expansion joints Embankment instability	Wind damage	Risk of subsidence on certain soils				Load on building roofs (if flat)	
	Waste storage & disposal	Storage areas need to be safe from flooding exposure	Increased odour production and decomposition of certain wastes	Storage containers risk losing contents		Increased odour production	Dispersal of odour		Operational Aspects	Aids decomposition
Warehouse / Distribution	**Buildings, parking and access**	Drainage & Surface water flood risk	Softening asphalt Expansion joints Embankment instability	Wind damage Traffic hazard	Subsidence Drainage/flooding Embankment instability	Softening asphalt Expansion joints Embankment instability			Hazardous conditions	
	Transport network (road, rail, airports)	Drainage & Surface water flood risk	Rail buckling, stretching overhead wires; other operational aspects	Wind damage				Operational aspects	Disruption to timely deliveries	
	Climate control inside buildings	Operational aspects; deterioration of goods	Operational aspect Increased capacity required	Operational aspects / wind damage		Impact on passenger numbers Impact on airport habitats, affecting maintenance and bird control		Operational aspect	Operational aspects	
	Electricity supply, IT infrastructure	Reduced reliability of service	Operational aspect Risk of “brown outs”	Operational aspects / wind damage			Changes to service efficiency	Operational aspect	Damage to exposed cables	
	Cranes / Lifts / Transporters	Operational aspects; disruption to service	Operational aspects	Wind damage, risk of structural collapse					Increased risk of freezing. Lifting equipment at risk of icing or snow load	
	Outdoor storage		Heat damage	Wind damage		Increased corrosion			Affects handling and display	
Manufacturing	**Electricity supply**	Surface water flood risk leads to Increased network failure Substation risk of flooding Underground cables at risk Operational issues for on-site power generation	Impact on demand Heat waves in summer could lead to “brown outs” Transformers may not be able to cool down enough overnight	Wind damage					Operational aspects;	
	Water supply	Flooding can contaminate water supply	Impact on water demand Increased maintenance		Restrictions during droughts Pipe burst (soil conditions)	Reduced source-water quality				

		Principal climate change impact								
		High Impact	**Medium High Impact**		**Medium Impact**			**Low Impact**		
Type	**Element / activity**	**Rainfall intensity**	**Max daily summer temperatures**	**Peak windspeed**	**Rainfall seasonal changes**	**Seasonal Temperature**	**Mean windspeed**	**Max daily winter temperatures**	**Snow**	**Humidity**
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Leisure	**Machinery**	Operational aspects for exposed assets	Risk of overheating	Operational aspects for exposed assets; Wind damage		Greater variation in performance requirements between summer & winter		Risk of freezing as frost level sinks.		Operational aspects
	Transport of goods (to and fro)	Operational aspects; flood events increase in frequency	Operational aspect	Hazardous driving conditions	Operational aspect;	Operational aspect;	Increased power requirement	Operational aspect	Hazardous driving conditions	
	Storage of raw materials	Flooding damage; “landslip” of bulk goods;		Dispersion of loose / light materials	increased weathering and maintenance of exposed assets. Capacity expansions. Increased energy requirements		Requirement to enclose structures affected by wind – lifting equipment, bulk solids handling & storage		Affects properties of bulk goods	Risk of condensation inside sensitive equipment
	Heating / cooling of buildings		A/C may be stretched to cope	Wind damage		Retuning of equipment	Insulation of buildings			Risk of condensation inside sensitive equipment
	Water supply	Flooding brings risk of contamination of drinking water	Water quality adversely affected		Risk of drought	Changes in supplied water temperature (e.g. less heating required for swimming pools etc)				Operational aspects, increased maintenance
	Outdoor courts, gardens, lawns, pools etc	Change of surface material and plants	Heat-sensitive species adversely affected	Wind damage	Change of plants, irrigation may be required	Change of plants		Pests may overwinter more easily	Operational aspects	
	Outdoor activities	Hazardous conditions	Heat exhaustion	Hazardous conditions	More pronounced seasonal changes of activity	Higher risk of certain insect-borne diseases			Hazardous conditions	
	Food & drinks		Higher cooling requirements; risk of bacterial contamination higher			Higher cooling requirements all year round				Aids decomposition